TOWARDS A GREATER KNOWLEDGE BASE – ENGAGING CHICAGO RIVER WATERSHED INTELLIGENCE TO DEMONSTRATE SYSTEMIC LANDSCAPE DESIGN STRATEGIES

BY

BRAM M. BARTH

THESIS

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Master's Committee:

Assistant Professor Gale Fulton, Chair
Associate Professor David Kovacic
Professor Bruce Rhoads

## ABSTRACT

Traditional landscape architecture design practices are limited by existing institutions and too reductive and site-focused. These practices typically lack the synthetic, flexible, and projective methods necessary for the effective planning, design, and management of complex regional landscapes. This thesis investigates the development of applicable strategies that harness contemporary design tools and techniques as well as an updated understanding of systems and complexity in order to effectively interconnect landscape design at the regional and site scales. Recognizing the need for an actual vehicle of study, this thesis engages the Chicago River Watershed (CRW) with the intent of demonstrating the application of these strategies. In this manner, systemic tactics grounded in an existing landscape context are developed to move landscape architecture closer to a role of disciplinary synthesizer.

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# CHAPTER 1 – INTRODUCTION

In a world facing extraordinarily complex challenges such as ever-expanding populations, environmental degradation, pollution of natural resources, over-dependence on fossil fuels, economic shortages, and wasteful consumerism, landscape architecture is arguably positioned as one of the most important disciplines of the twenty-first century due to its breadth of topical concerns. Active in fields such as ecology, horticulture, landform, material performance, social awareness, and public interaction, landscape architecture often touts itself as being the great synthesizer of disciplines. Implied within this assertion is a supposed inherent capacity to move between fields and their respective scales and the ability to maintain a working dialogue between disciplines. A critical reflection on these distinguishing characteristics in actual practice, however, proves them to be more exception than rule. As a result, this thesis is rooted in a critique of traditional landscape architecture design practices as being both limited by existing institutions and in themselves too reductive and site-focused. These practices typically lack the synthetic, flexible, and projective methods necessary for the effective planning, design, and management of complex regional landscape contexts.

The purpose of this thesis is to develop applicable strategies that harness contemporary design tools and techniques as well as an updated understanding of systems and complexity in order to effectively interconnect landscape design at the regional and site scales. Recognizing the need for an actual vehicle of study, this thesis engages the Chicago River Watershed (CRW) with the intent of demonstrating the application of these strategies on real sites with real problems. In this manner, systemic tactics grounded in an existing landscape context are developed to move landscape architecture closer to its goal of disciplinary synthesizer.

## CHAPTER 2 – THEORETICAL FRAMEWORK

A discussion of design in the twenty-first century, from technological innovation to the creation of built environments, is obligated to be mindful of issues related to the concept of sustainability. Concern for the environment is not a new phenomenon, but public awareness and understanding within the last ten to twenty years has grown significantly, mostly due to a growing body of scientific evidence indicating the often deleterious effects of human interactions on the environment. Growing numbers of people are now conscious of the importance of energy efficiency, manufacturing processes, waste cycles, and the impacts our designed systems (buildings, infrastructure, transportation corridors, agricultural fields, etc.) are having on the greater environment. Yet, while the Brundtland Commission definition of sustainable development as that which "meets the needs of the present without compromising the ability of future generations to meet their own needs" (UNGA 1987, 54) is generally accepted in spirit, the means, methods, and criteria of evaluation for achieving such a measure are not.

In 2002, Michael Speaks, Dean of the College of Design at the University of Kentucky, revived the phrase 'design intelligence' to describe "that 'unseen' array of techniques, relationships, dispositions, and other intangibles, that enables post vanguard practices to innovate by learning from and adapting to instability, and in so doing to distinguish themselves from their vanguard predecessors" (Speaks 2002, 16). Building on this concept, this study uses the term 'intelligence' to represent the bricolage of knowledge that individuals, firms, project teams, non-profits, and municipalities, among others, must develop to not only operate at the most basic design level but more importantly, to fully engage with today's complex social-ecological challenges. These intelligences come in multiple forms, including extended periods of professional experience or cultivated research as well as interpretation of real-time field data and awareness of pertinent current events. For example, professionals may be initially obtained for a singular service, but once engaged, their greater knowledge base may reveal more effective design strategies, bodies of information that support improved project alternatives, or opportunities for funding. Additionally, emerging site information or cultural events may trigger the utilization of other forms of knowledge that might not otherwise have been considered by project members. As these intelligences serve as the basis for decision-making, the active cultivation of an up-to-date library of knowledge is critical for the twenty-first century designer.

The connection between sustainability and intelligence comes into sharper focus when one considers the notion of systems thinking. In *The Ecosystem Approach: Complexity, Uncertainty, and Managing for Sustainability*, James Kay presents a useful criticism of society's uncritical acceptance of conventional scientific approaches to world issues, whereby greater wholes are described as merely the sum of their parts. On the contrary, complex situations typically involve high levels of uncertainty, which make planning for their sustainable future all the more difficult. For instance, Kay uses the example of evapotranspiration in a wetland – when the evapotranspiration measurements of individual plants are added to the evaporation of open pans of water, the total value is actually less than that of the wetland's evapotranspiration. The question remains whether wetland plants increase local humidity and consequently decrease open water evaporation or if increased open water decreases plant evapotranspiration. This wetland example also exhibits the quality of nonlinearity possessed by complex systems that do not lend themselves to simple, linear models of causality. In fact, nonlinear logic accepts that complex situations maintain multiple scenarios as future possibilities, which in turn maintain their own degrees of uncertainty. Thus, while linear scientific approaches have proven to be extremely valuable throughout history, they are also inherently limited in the types of solutions they can generate. Kay proposes that systems thinking, while not without its own shortcomings, has emerged as a better way to address complex situations than has traditionally been deployed.

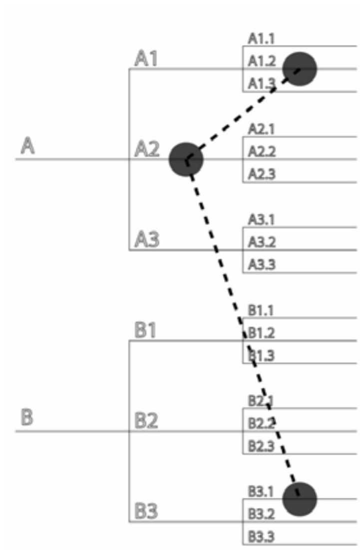



*Image 1 – Diagram presenting design scenarios A and B and their respective sub-scenarios; nonlinear logic suggests that connections drawn between different scenarios may ultimately lead to more effective design solutions.*

Systems thinking also embraces the concept of self-organization, a phenomenon whereby a system develops its identity through properties such as feedback loops and buffering capacities. This phenomenon is exemplified by a school of fish; while each fish exists individually unto itself, the school, as a single entity, is systemically comprised of multiple fish operating together. Self-organization is also manifest in the ways systems respond to disturbance where Kay refers to a scenario involving fire. The occurrence of small, periodic fires throughout certain temperate forests of North America assists in releasing nutrients, opening space for emerging seedlings, and limiting forest fuel levels that might otherwise lead to more catastrophic conflagrations in the future. An isolated examination of a single fire event would fail to recognize this systemic, self-organized feature. It might also lead to the promotion of forest management and recreational design practices that suppress small fires, subsequently enabling the potentially disastrous increase of biomass that would feed blazes similar in scale to the one that occurred in Yellowstone in 1988 (Kay 2008).

Sustainability accordingly depends on the most comprehensive understanding of systems in order to make responsible design decisions, particularly those involving the needs of present and future generations. This requires not only engagement with the multiple logics of any complex system but also an adaptive ability to interpret emerging forms of intelligence such as new site conditions, regional relationships, or cultural factors. This flexibility is akin to ecologist C.S. Holling's concept of adaptive management that seeks to accrue information over time in order to improve future design and management practices. Designers attempt to simultaneously understand and change systems (Holling 1978). This adaptive ability is often challenging, however, given the human tendency toward reductionism and being set in its ways.

In extraordinarily complex situations, traditional scientific approaches to understanding, such as deduction and induction, are limited.

*Deduction:* *If A equals B, and B equals C, then A must equal C.*

*Induction:* *If all observed A's are black, then all A's must be black.*

While logical, these approaches cannot offer new information beyond given parameters or project creative alternatives. The design and planning of today's complex systems subsequently requires an alternative approach, that of abduction. Described by John Kolko, Founder and Director of the Austin Center for Design, as the "the argument to the best explanation" (Kolko 2010, 20), abduction involves utilizing the intelligences at hand to develop reasoned guesses.

*Abduction:* *I have done A before and have seen B under similar circumstances; as a result, I project C as a plausible outcome.*

Abduction does not necessarily lead to direct, final solutions and similar to induction, may result in false conclusions. However, unlike the original two forms of inference, abduction maintains the ability to introduce a new variable (*C*) that did not exist in the original premises.

This adaptive ability also extends into the relationship between scales. Complexity inherently involves connections between opposite ends of the global and detailed spectrum where fluid design engagement is not only useful but critical. In describing his design strategy, Alan Berger, Associate Professor of Urban Design and Landscape Architecture at the Massachusetts Institute of Technology, observes, "I promote using the new tools of analysis [GIS, www, etc.] to expand site program and strategy outward, adjusting and feeding back small scale issues based on large scale logic all the way through the design process. The resulting project is smarter and more sustainable

[able to live without expensive, infinite inputs] if larger scale logic is embedded in the smaller scale proposals" (Berger 2009, 14-15).

The extent to which designers engage multiple scales, however, becomes a unique challenge of knowing how to frame systems. One can easily succumb to look infinitely upward toward an ever-expanding view of global systems or gaze infinitely downward to discover an endless array of details. As neither is achievable in the absolute, designers must decipher the importance of situational elements, relationships, and hierarchies and accept that there will always be unknown unknowns. Elliot Eisner, emeritus professor of Art and Education at the Stanford University School of Education, explains the necessity in accepting unknowns when taking on new and emerging complex situations: "The idea of wishing to lose control is, in our highly rationalized view of procedure, utterly counter intuitive. We want to take control rather than give it up. Yet, in giving it up, new possibilities are likely to emerge. Thus, action embedded in surprise becomes the means through which new ideas are formulated and expressed" (Johnson 2007, 19).

Given the extent of intelligences needed to effectively engage the complexities associated with sustainability, a need emerges for a more synthetic assemblage of tools and techniques to frame planning and design problems. Such complexities also demand professionals versed in what Anthony Cortese, President of Second Nature Education for Sustainability, refers to as 'lateral rigor' whereby focus is placed on the ability to move across disciplines in a horizontal way; the opposite of this is 'vertical rigor' involving knowledge developed by specialists (Cortese 2001). While many disciplines may be able to adapt to this approach, landscape architecture maintains a particular advantage given its indeterminate medium and the ubiquitous nature of its namesake. As such, the role of landscape architects among designers may emerge as that of synthesizer and facilitator. In a broader disciplinary scope, landscape architecture may extend to or even birth a new professional, a sort of proactive design liaison between generalists and specialists.

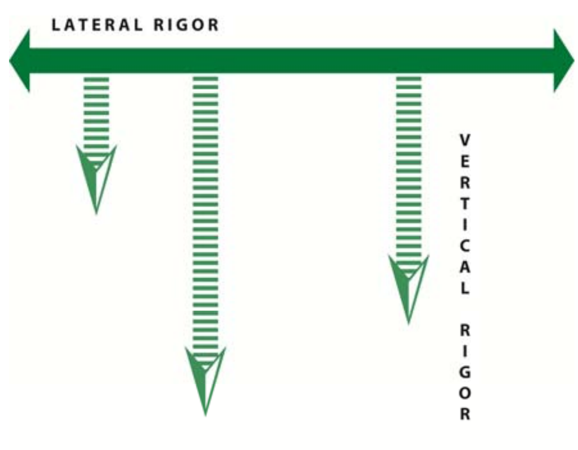



*Image 2 – T-shaped professional diagram demonstrating the relationship between lateral and vertical rigor (adapted from IDEO model).*

## CHAPTER 3 – CONTEXT

James Corner, landscape theorist and principal of James Corner Field Operations, notes that "a good strategy remains dynamic and open and thereby assures its own longevity. It is more conversational and engaging than it is confrontational or assertive" (Corner 2005, 1). This is particularly relevant in methodologies related to landscape design, where flexibility is critical to grow, develop, and adapt concepts to an array of systems and active conditions. "Too rigid a strategy will succumb to a surprise or to a logic other than that for which it was designed, and too loose a strategy will succumb to anything more complex or to anything more highly organized and better coordinated" (Corner 2005, 1). This flexibility is important when considering the relationship between sustainability, intelligence, and systems thinking. Indeed, the credo of nature involves a never-ending process of adaptation and change. According to Daniel Botkin, Professor Emeritus, Department of Ecology, Evolution, and Marine Biology, University of California, Santa Barbara, the belief in the constancy of nature is "a theme that runs throughout Western history, and has been the predominant perspective of environmentalism during the past 20 years…Scientists know now that this view is wrong at local and regional levels – whether for the condor and the whooping crane, or for the farm and the forest woodlot – that is, at the levels of population and ecosystems. Change now appears to be intrinsic and natural at many scales of time and space in the biosphere" (Botkin 1990, 9).

Ironically, human tendency is adverse to change where we feel more comfortable when we are in control; when everything adds up to the way it was expected; and when problems can be traced to a source, corrected, and dismissed. This rarely occurs in instances of design, especially when issues of complexity are engaged. Donald Schön, Ford Professor of Urban Studies and Education at MIT and contributing developer of the theory and practice of reflective professional learning in the twentieth century, observes that many challenging circumstances today "do not present themselves as problems at all but as messy, indeterminate situations" (Johnson 2007, 15). Yet, traditional planning and design strategies still cling to reductivist approaches, expectations, and organizational structures. Best management practices are often employed as proven methods and solutions to assist in reducing production time. While this is common, one may ask what is lost in consistently defaulting to such an approach. As Richard J. Boland, Eliz. M. and Wm. C. Treuhaft Professor of Management at Case Western Reserve University, notes: "Professional managers often resort to mimicking 'best practices' of their industry as a preferred course of action, citing the management maxim, 'Don't reinvent the wheel' even though reinventing the wheel might be precisely what a situation calls for" (Boland 2008, 17).

This approach is difficult when considering the challenges associated with explaining complex dynamics to clients and the public in general. 'Messy, indeterminate situations' often cannot be sufficiently represented by one or two pieces of data. Similarly, the synthesis of intelligence and design ideas takes time. As described by Michael Michalko, acclaimed creativity expert: "Like our first impressions of people, our initial perspective on problems and situations are apt to be narrow and superficial. We see no more than we've been conditioned to see – and stereotyped notions block clear vision and crowd out imagination. This happens without any alarms sounding, so we never realize it's occurring" (Michalko 2001, 19). Yet, because the synthetic process is internal and typically lacks an evidenced, formal structure, many stakeholders discount the true value of the process and may dismiss certain parts of it as a 'waste of time.' A designer who quickly delivers a completed, mediocre concept may be seen as industrious while a designer who presents a new, complex, half-concept that holds greater potential to emerge as a truly fascinating project may be dismissed as inefficient, disorganized, and unproductive.

Julia Wondolleck and Steven Yaffee present numerous examples of these collaborative challenges in *Making Collaboration Work: Lessons From Innovation In Natural Resource Management*. In one study regarding the United States Forest Service, an agency participant observes:

> *"We at the district feel that what we have accomplished has been a success. Rather than going through the traditional process and fighting the appeals, we have something up front that everybody agrees with and everybody thinks should be done….We have a better working relationship with a lot of people in the community, which is very important. [But] the forest supervisor's office thinks that we should have accomplished more than we have. The project has taken too much time, and they haven't seen the products that they wanted to see. They think that we spent too much time dealing with internal issues among the group – what should be done, what shouldn't be done"* (Wondolleck 2000, 55).

The participant goes on to note that initial enthusiasm for an unconventional pilot project was high, but soon, traditional measuring sticks for end results started to be imposed:

> *"They give us a certain amount of money, but they don't want to know that we had a nice friendly group discussion and that we are going to go off and do this and that. They want to know what date you are going to have a completed NEPA document in hand because that is the end product that they are looking for, even though the idea was to get away from that with ecosystem management"* (Wondolleck 2000, 55).

It is within these types of professional contexts that this study is framed. However, to avoid over-reliance on theory and abstract speculation, this thesis has selected the Chicago River Watershed (CRW) as a vehicle of study. Concepts such as sustainability, intelligence, and systems thinking may then be engaged more properly and applied to an actual landscape media. This also enables a greater opportunity to demonstrate the use of pertinent strategies and tactical tools and assess their value in terms of strengths, weaknesses, opportunities, and threats.

*Image 3 – The Chicago River Watershed and its context at the national, state, and regional scales.*

Application of systems thinking is particularly useful when considering an exploration of watershed dynamics, including hydrologic, geomorphologic, and biologic as well as policy and management processes at this larger scale. Water is arguably the most important natural resource on Earth, playing critical roles in not only the evolution of species and the emergence of differing natural ecosystems but also the successes and failures of human civilizations. More specifically, P.J. Boon, contributing editor of *Global Perspectives on River Conservation: Science, Policy and Practice*, notes how rivers themselves have "been an integral part of human development throughout history," providing drinking water, irrigation, and a mode of transportation as well as forming political boundaries, obstacles to expansion, and militaristic defense (Boon 2000, xi). Ironically, these same rivers have also suffered the most out of all of our available natural resources, enduring over-consumption, manipulation of floods and droughts, and massive amounts of pollution (Boon 2000). Yet while management in practice of water as a resource has existed for thousands of years, the emergence of watershed planning, design, and management as a discipline and field of study is relatively new, having emerged within approximately only the past century (Saha 1981).

Along these lines, a large body of literature has noted that one of the most critical challenges of successful implementation and enforcement of comprehensive watershed planning and design strategies is the establishment of institutions/organizations that effectively collaborate with each other. Maynard Hufschmidt, Professor in the Department of City and Regional Planning at the University of North Carolina at Chapel Hill, observes that "ignoring the problems associated with project implementation and institutional arrangements is the common weakness of many of the existing watershed management efforts" (Hufschmidt 1991, 17). Additionally, Jianguo Liu, University Distinguished Professor and Rachel Carson Chair in Sustainability, Department of Fisheries & Wildlife, Michigan State University, observes that "despite some notable achievements in interdisciplinary research, the promise of working across disciplines has not been uniformly realized and the barriers (e.g., reward system, institutional structure) to sustained successful collaboration remain very high" (Liu 2007, 646).

The CRW system, with a history steeped in natural alteration and monumental engineering feats, is no exception to this context. Streams that once meandered sultrily through prairie were channelized into functional transportation corridors, connecting Great Lakes commerce to the inner Midwest and establishing Chicago as a key regional waterway access point. Clear waters were transformed into exposed sewage canals to meet urban sanitary needs and ultimately served as the grounds for reversing the river's flow. Because Chicago draws its drinking water from Lake Michigan, river pollution requires containment. Flow was (and continues to be) directed to the southwest via the Sanitary and Ship Canal, eventually connecting to the Des Plaines, Illinois, and Mississippi Rivers. Additionally, a watershed that once contained countless prairie, wetland, and woodland landscapes has been converted into one dominated by impervious surfacing and urban sprawl (Hill 2000).

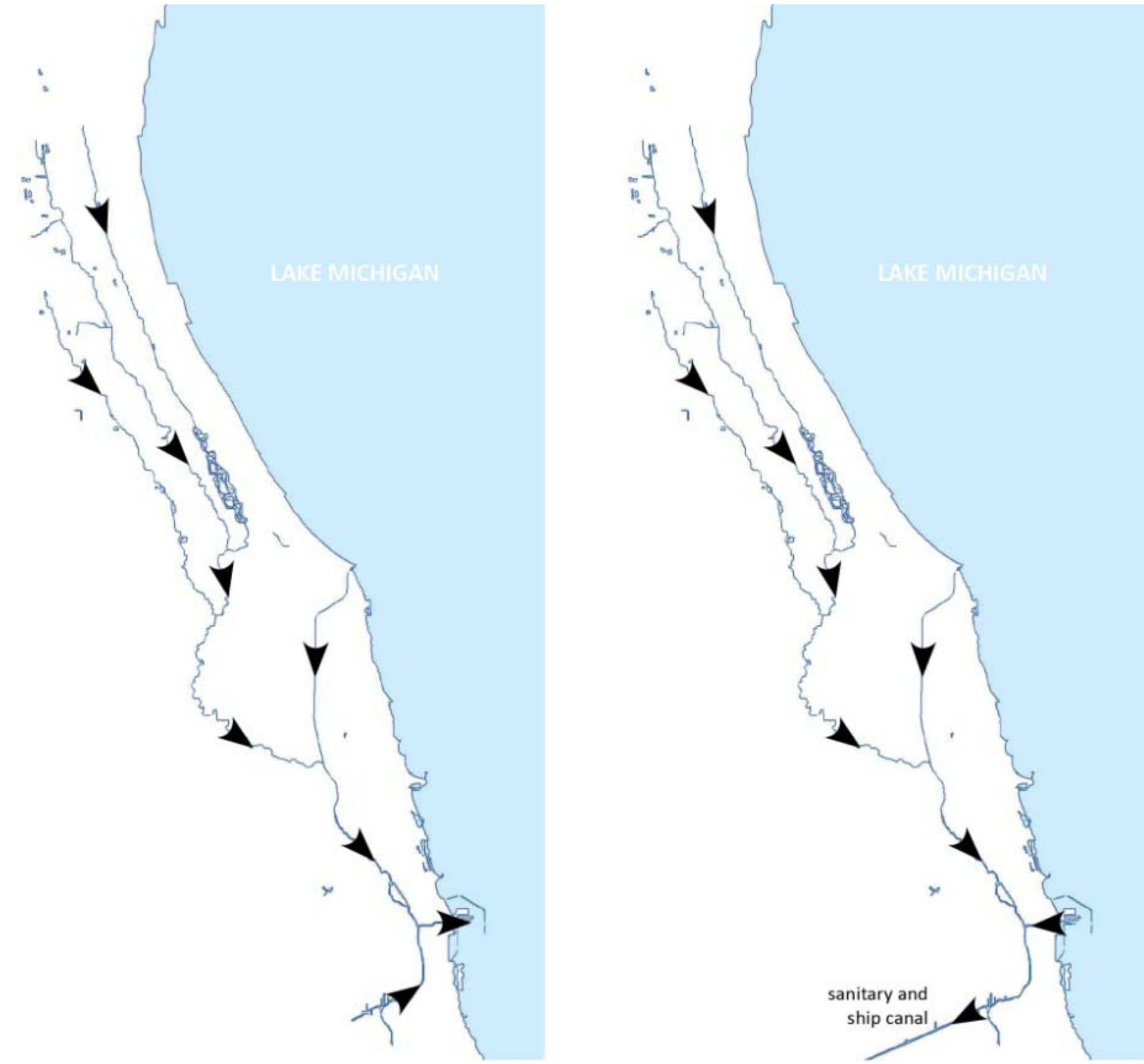



*Image 4 – Directional flow of the Chicago River before (left) and after (right) reversal via construction of the Sanitary and Ship Canal.*

Today, the CRW system is over 180 square miles and encompasses seven primary sub-watersheds. Its northern portion – consisting of three tributaries linked to a main branch – combines with the reversed main stem in downtown Chicago to flow south along one main channel. The hydrologic system includes a complex network of storm sewers as well as environmentally problematic combined sewers. During periods of high storm flow, the latter system becomes overburdened and overflows untreated sewage directly into the hydrologic system. As a result, the Tunnel and Reservoir Plan (TARP; a.k.a. Deep Tunnel; see Image 7) was developed to redirect overflows to temporary holding reservoirs via large, underground tunnels. Reservoir water is eventually treated and returned to the hydrologic system, yet project completion is not estimated until after the first quarter of the twenty-first century.

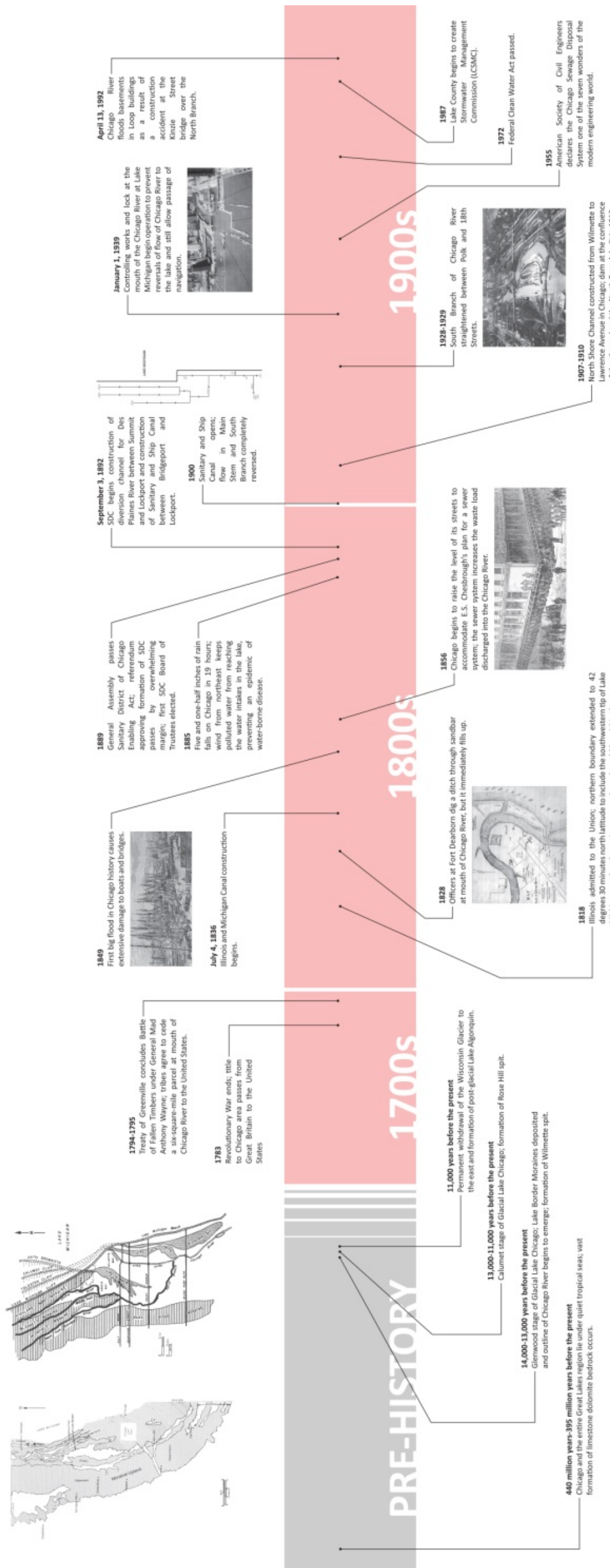



*Image 5 – Chicago River timeline (adapted from Hill 2000).*

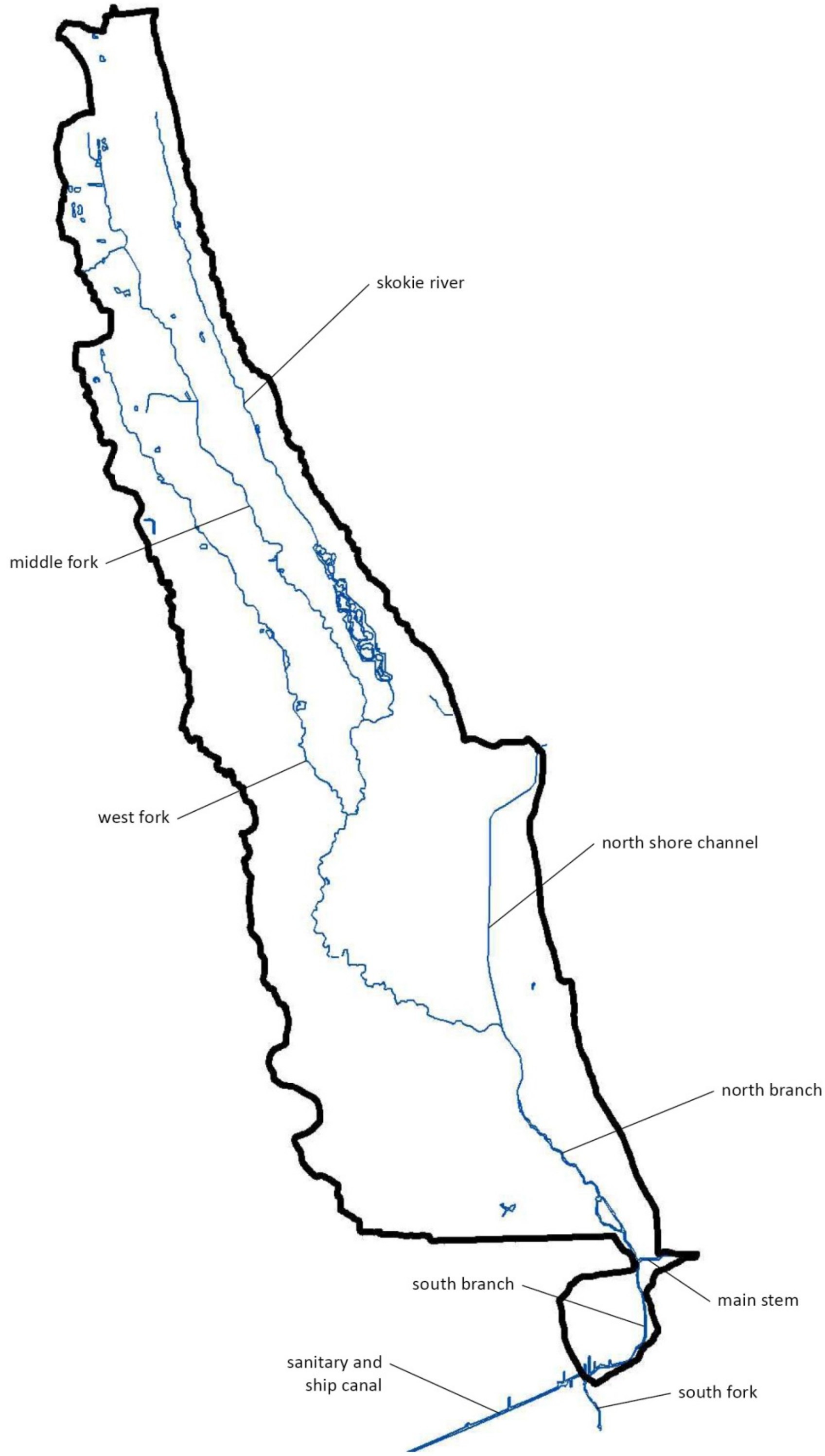



*Image 6 – Chicago River Watershed boundary and contributing channel branches.*

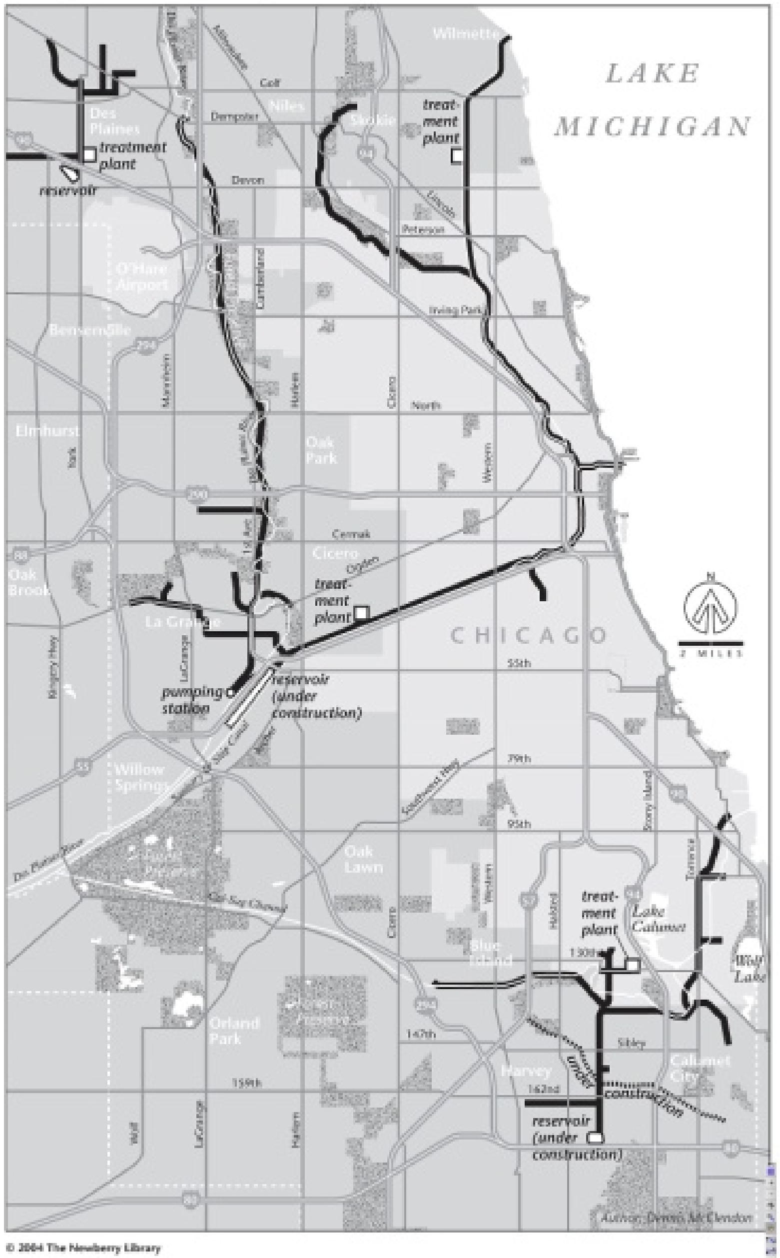



*Image 7 – Chicago's Deep Tunnel System in 2003 (image courtesy James R. Grossman, Ann Durkin Keating, and Janice L. Reiff, eds.,* The Encyclopedia of Chicago *[University of Chicago Press, 2004]. Copyright The Newberry Library).*

From an institutional standpoint, the CRW system supports a network of organizations that includes four primary drainage districts, numerous facility planning areas and sanitary districts, two key stormwater management commissions, and multiple regulatory agencies. Additionally, the watershed also lies within the bounds of 32 independent municipalities and contains countless non-for-profit and community organizations both directly and indirectly connected to the river system. Given the overlap of both ecological and institutional complexity, the CRW serves as a worthy landscape to engage strategies and tactics associated with concepts such as sustainability, intelligence, and systems thinking.

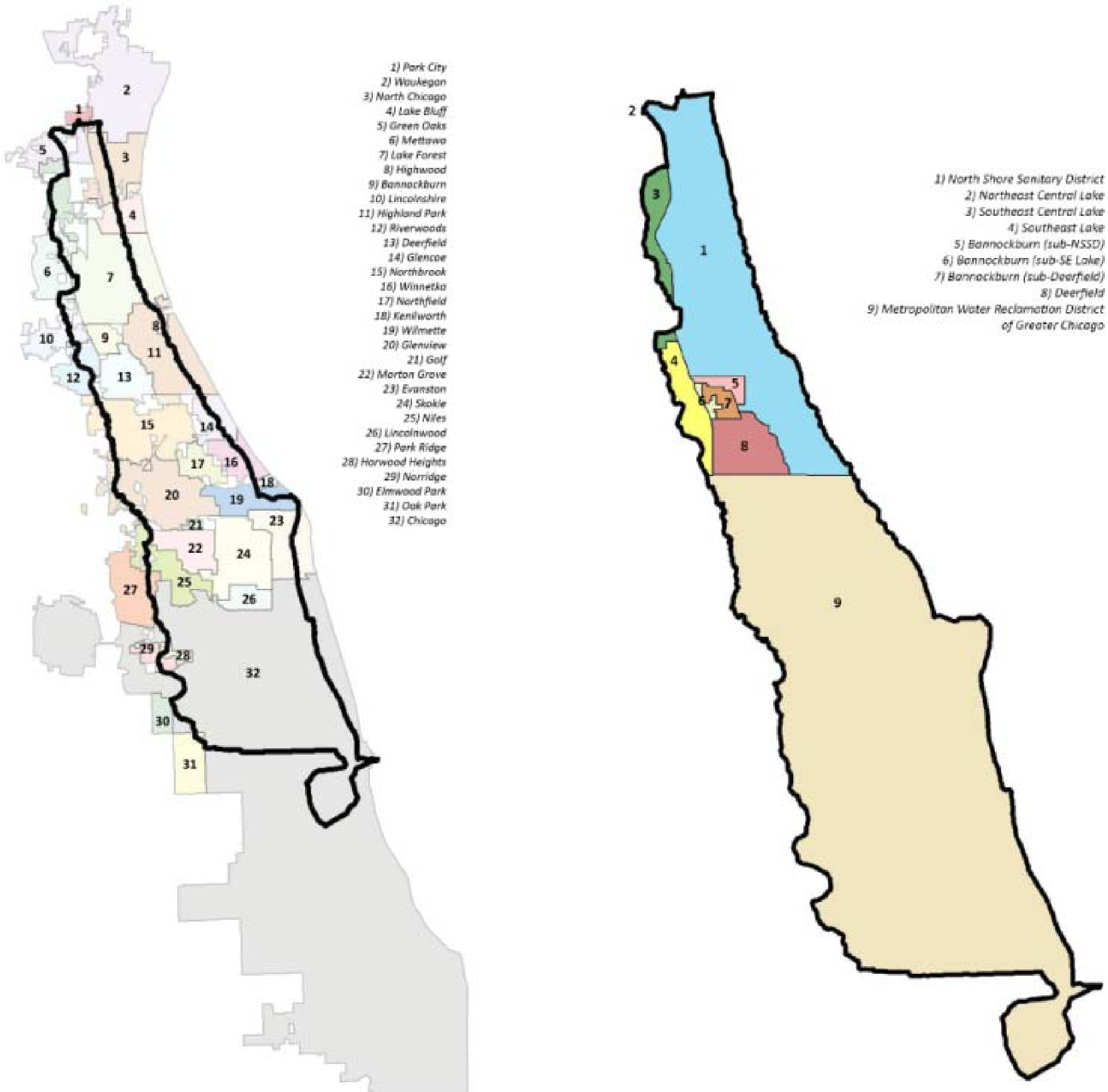



*Image 8 – Chicago River Watershed divided according to two different institutional jurisdictions – municipal boundaries (left) and facility planning areas (right).*

**CHAPTER 4 – WORK PRODUCT**

In 2006, the History Channel conducted a competition entitled City of the Future: A Design and Engineering Challenge that asked designers from three cities, New York, Chicago, and Los Angeles, to develop a conceptual plan for their respective city 100 years into the future. In response, Chicago-based UrbanLab, founded by Martin Felsen and Sarah Dunn, proposed Growing Water, a design concept that projected water valued as the new oil. Inspired by Chicago's "'Emerald Necklace' of public parks, boulevards and waterways" as well as the Chicago River reversal and the Deep Tunnel project, Growing Water focuses on the development of "Eco-Boulevards" within the future city (UrbanLab 2011). Running perpendicular to Lake Michigan, these corridors serve as treatment systems that direct water back to the lake. The concept also calls for the re-reversal of the Chicago River and the conversion of the Deep Tunnel into a system of mass transit.

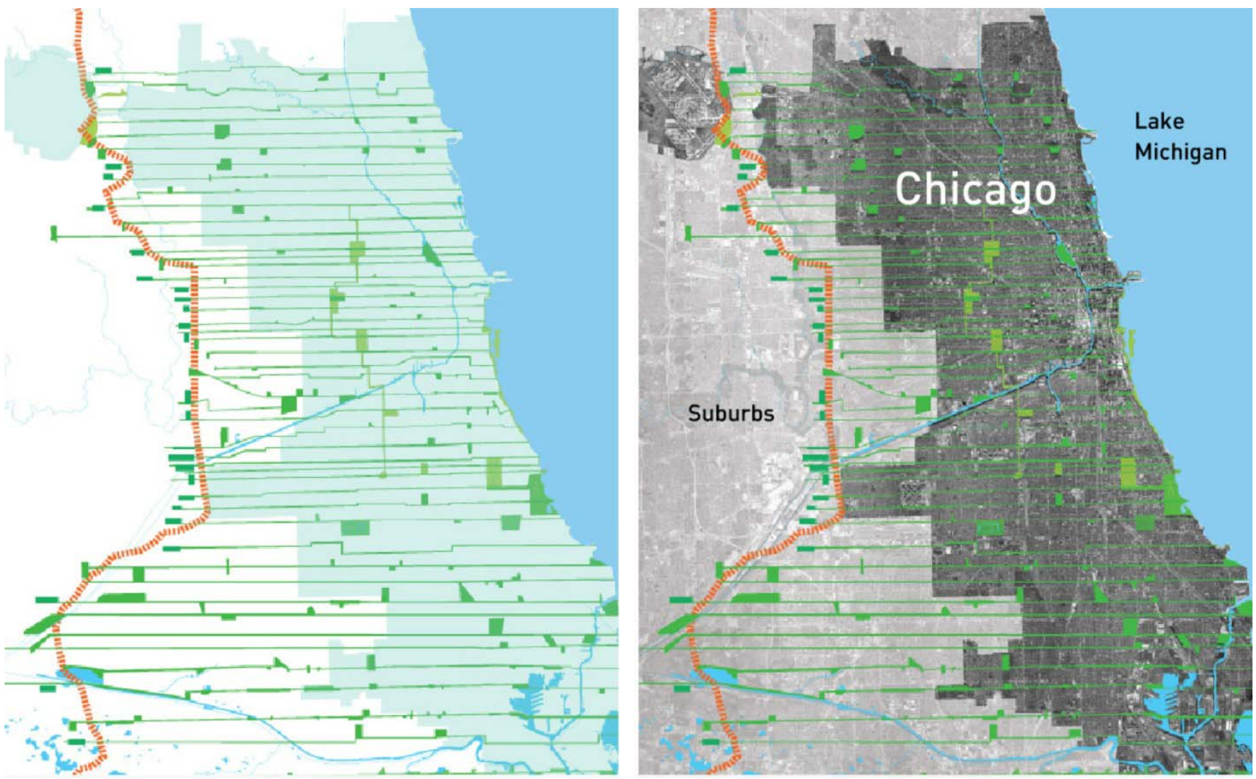



*Image 9 – Growing Water conceptual imagery (UrbanLab 2011).*

Building upon Growing Water, this study adopts the Eco-Boulevard concept as a basis for design but continues its development through a series of strategies, tactics, and tools rooted in the theoretical concepts previously discussed. These tactics are subsequently organized within a framework consisting of three primary categories – Systems Thinking, Data Engagement, and Design – where specific approaches are demonstrated through a variety of applications. A toolbox of methods and approaches emerges where focus is not on Chicago River Watershed (CRW) solutions per se but the value of the tactical methods themselves.

A design analysis of Growing Water produced two fundamental criticisms. The first addresses the failure to recognize sub-watershed relationships where proposed Eco-Boulevards appear to breach multiple hydrologic divides and consequently ignore natural drainage patterns. The second criticism addresses the proposed implementation of these Eco-Boulevards in only Chicago and its western suburbs. In fact, the Chicago River extends over 20 miles to the north and includes approximately 117 square miles of additional watershed surface area. It is important to note, however, that the intent of these criticisms is not to discredit the original concept but rather, identify areas for further speculation and conceptual development. The resulting design product generates a regional plan that extends the Eco-Boulevard concept to the north and expands corridor utilization beyond only west-east road alignments. Hydrologic integrity is addressed by framing design interventions within their respective sub-watersheds. What follows is the series of strategies, tactics, and tools utilized to further develop the Growing Water concept.

***Systems Thinking***

The focus of Systems Thinking is to recognize and address general 'big picture' ideas at more global scales. Greater wholes viewed in the context of greater complexities are the focus. This recalls Kay's discussion of wetland evapotranspiration – do wetland plants increase local humidity and consequently decrease open water evaporation or does open water decrease plant evapotranspiration? The critical challenges associated with Systems Thinking lie in framing larger contexts and coping with elevated levels of uncertainty where three primary tactics have been utilized – Systems Recognition, Scale Fluidity, and Nonlinearity.

*Systems Recognition*

Systems Recognition involves the fundamental awareness of larger complexities. In this study, the CRW's context has been established within the main watersheds of the United States and the State of Illinois (see Image 3). A reframed perception also reveals that the CRW can be divided into seven separate sub-watersheds (see Image 10). The watershed can simultaneously be divided among 32 different municipalities (see Image 8). The generation of these images frames the watershed within three contexts and enables the designer to gain a better understanding of the system. While a designated land area may constitute one sub-watershed within a larger drainage network, it may be comprised of multiple municipalities that contribute to greater complexity. From these types of exercises, the designer is able to maintain a larger contextual awareness that informs future design decisions. This is specifically evidenced by the aforementioned criticism of UrbanLab's failure to recognize sub-watersheds in its implementation of Eco-Boulevards.

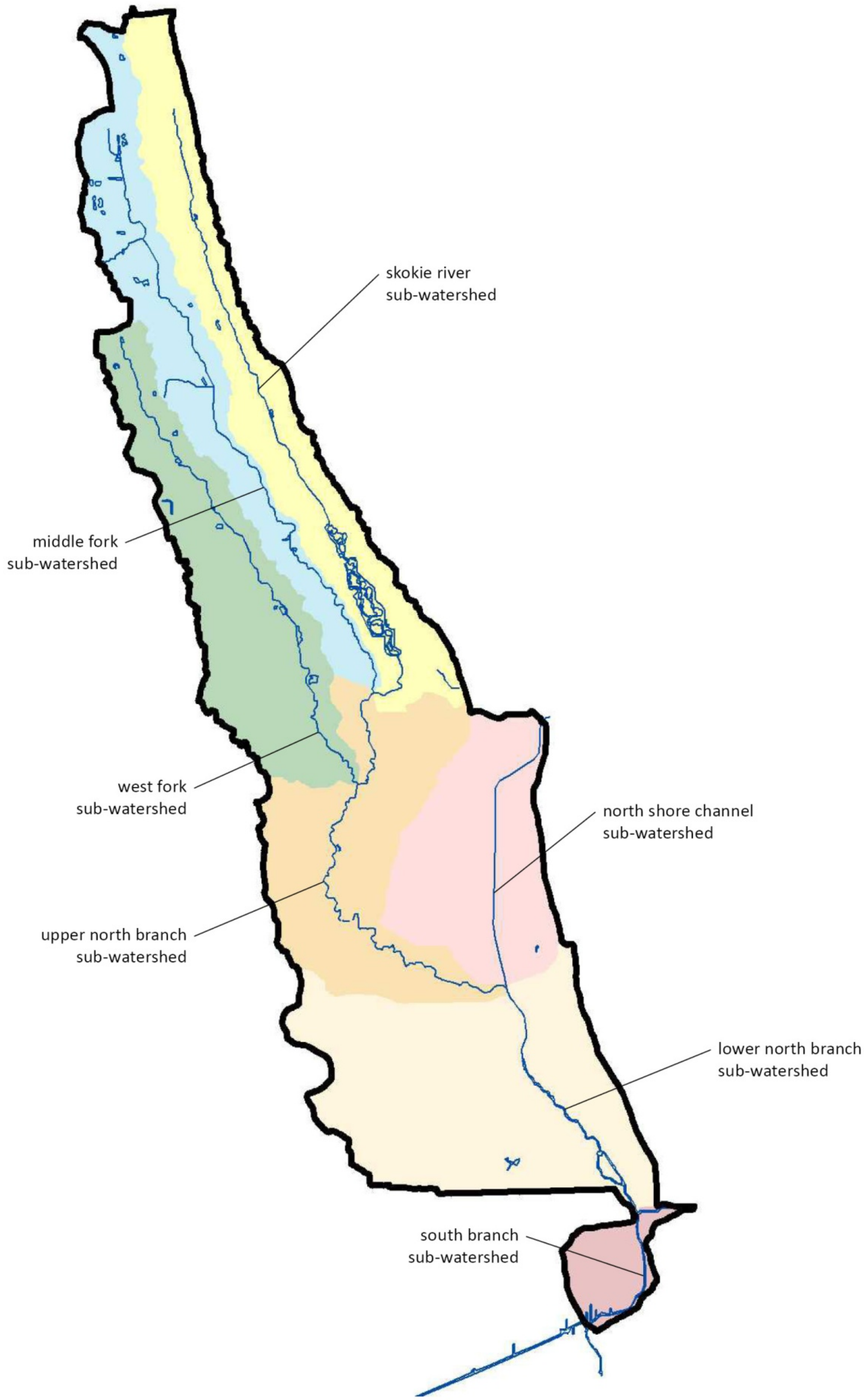



*Image 10 – Sub-watershed divisions of the Chicago River Watershed present an additional layer of internal complexity.*

*Scale Fluidity*

Scale Fluidity is inspired by Berger's observation that projects can be smarter and more sustainable if large-scale logic is embedded in smaller-scale proposals. Within the context of the CRW study, this involves the identification of key hydrologic sites based on regional analyses. Sites are identified according to their hydrologic potential to contribute to the larger Growing Water concept (see Image 11). Next, quick site-scale designs and prototypes speculate on local interventions and their subsequent implications on the larger watershed system. For instance, rain gardens and bioswales are implemented along roadways to alleviate surface runoff burdens on the larger storm sewer network (see Image 12). Additionally, temporary storage basins (see Image 13) are established at key intersections to further reduce pipe system inputs. By maintaining a regional goal focused on reducing inputs to a larger, overtaxed system, the designer establishes a guideline for smaller site proposals. Subsequently, this tactic enables designers to seamlessly work between scales, linking site-specific decisions to greater contexts and framing their importance in larger systems.

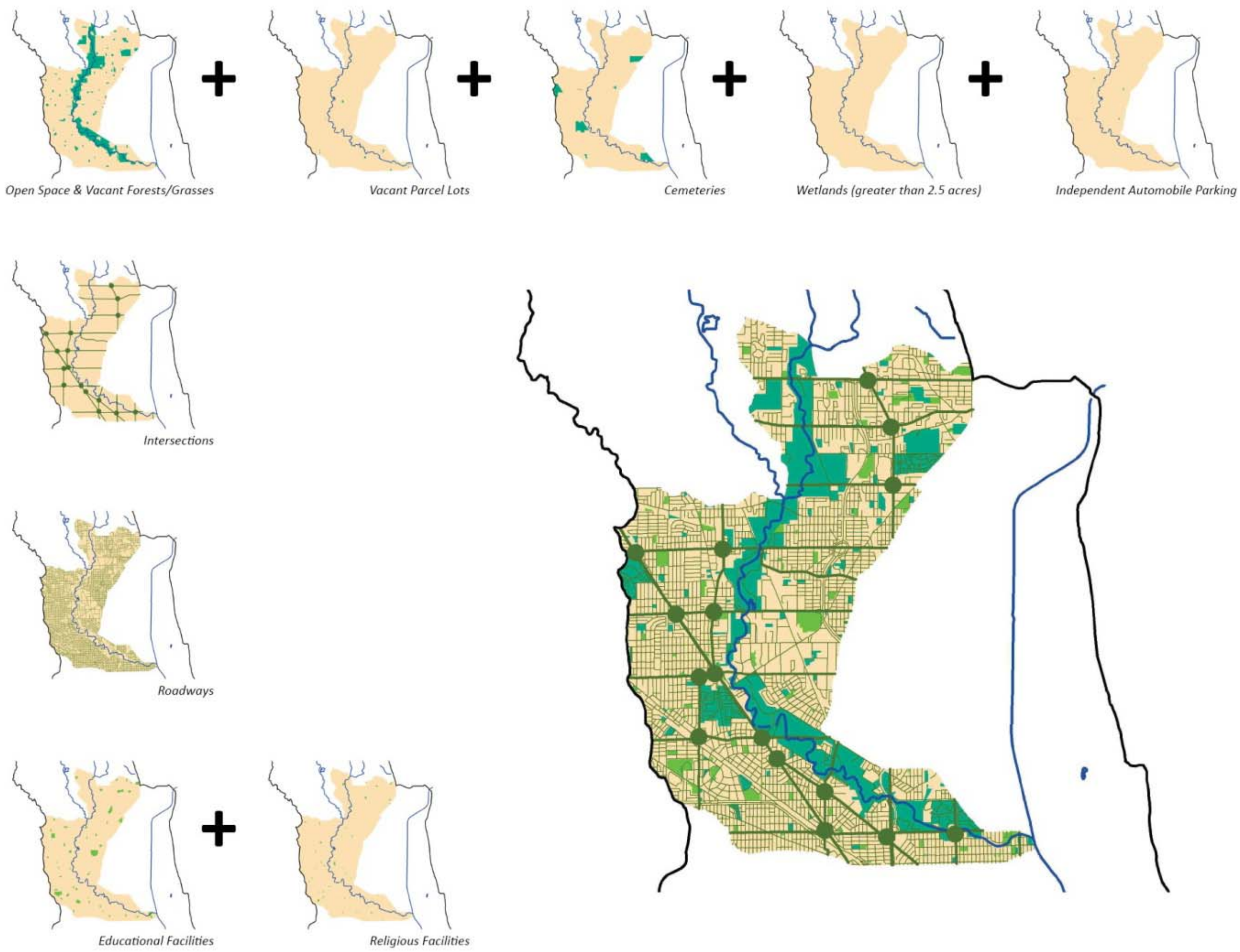
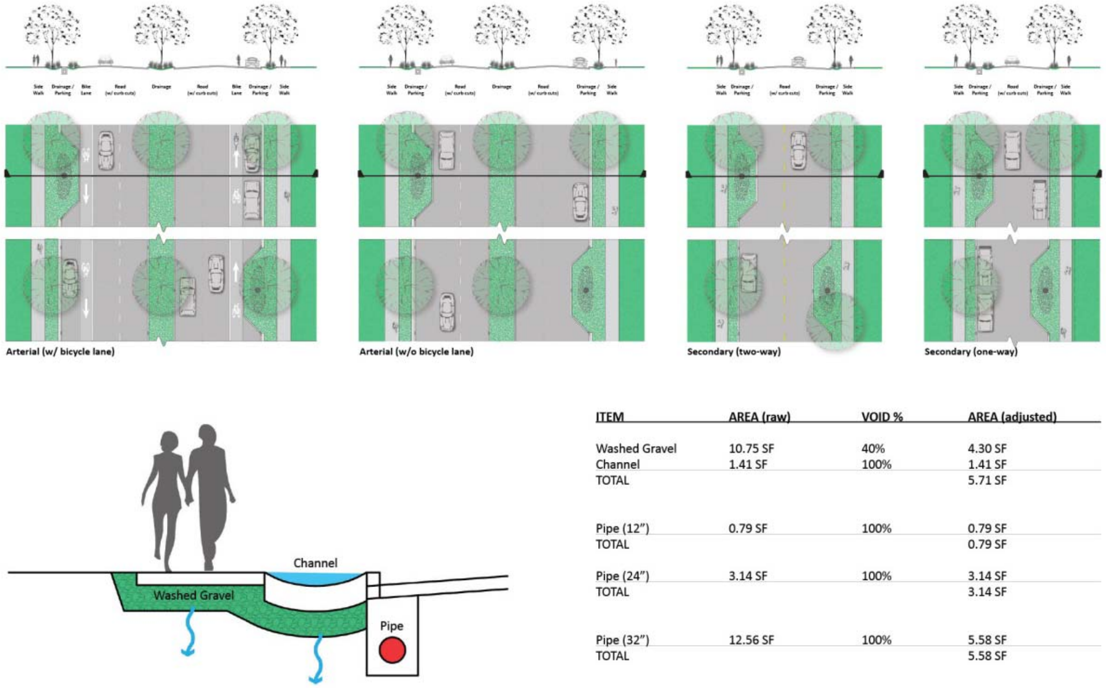



*Image 11 – Regional analyses identify landscape elements that hold hydrological potential to contribute to the Growing Water concept; the emerging composite diagram (lower right) identifies opportunistic design locations and their spatial relationship to other elements.*




| ITEM | AREA (raw) | VOID % | AREA (adjusted) |
|---|---|---|---|
| Washed Gravel | 10.75 SF | 40% | 4.30 SF |
| Channel | 1.41 SF | 100% | 1.41 SF |
| TOTAL | | | 5.71 SF |
| Pipe (12") | 0.79 SF | 100% | 0.79 SF |
| TOTAL | | | 0.79 SF |
| Pipe (24") | 3.14 SF | 100% | 3.14 SF |
| TOTAL | | | 3.14 SF |
| Pipe (32") | 12.56 SF | 100% | 5.58 SF |
| TOTAL | | | 5.58 SF |

*Image 12 – Roadway cross sections and respective plan views (top) present design prototypes for the range of urban road types and corridors identified in regional analyses; a section diagram and corresponding table (bottom) relate the hydrologic storage capacities of this 'softer' infrastructure to that of traditional stormwater piping.*

*Image 13 – Conceptualization of an intersection identified in regional analyses; a temporary storage basin collects redirected stormwater from neighborhood bioswales.*

*Nonlinearity*

Nonlinearity accepts that complex situations maintain multiple scenarios as future possibilities, which in turn maintain their own degree of uncertainty. This can occur both temporally and spatially. The CRW study engages the latter through an analysis of high-intensity imperviousness where impervious 'hotspots' emerge throughout the region (see Image 14). A more detailed focus on one such hotspot reveals how a parking lot's imperviousness may be 'softened' (see Image 15). The emphasis here, however, is not on the specific design proposal but rather on how the site was identified and re-designed according to intelligence of regional imperviousness. Not only does this intervention address a regional issue at the site scale, but it also establishes connections between sites throughout the entire watershed that might not otherwise have been recognized. Two geographically separated municipalities might now come together to exchange information and engage issues of combating imperviousness. Through the utilization of this tactic, designers gain the ability to transcend localized challenges and reach out to others faced with similar circumstances for conceptual feedback.

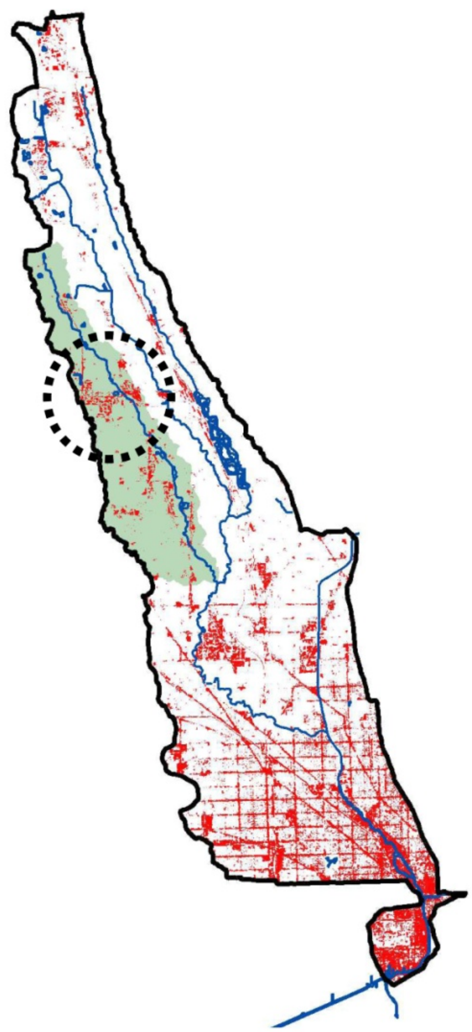


*Image 14 – Mapping of high-intensity impervious areas within the Chicago River Watershed identifies 'hotspots' of imperviousness; one such area has been selected for further design conceptualization and development.*

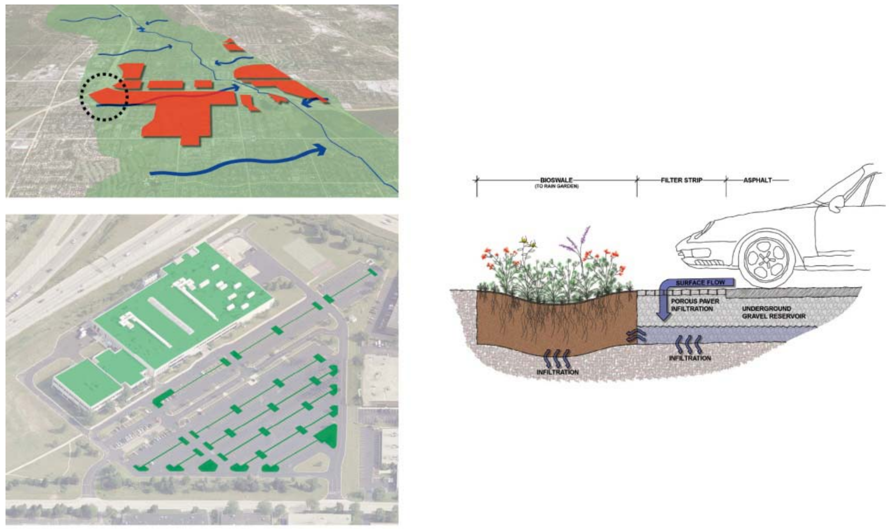



*Image 15 – Nonlinear scale fluidity is maintained where conceptual details of one retrofitted site (such as the 'softened' parking lot shown above) may be applied to, or used as design inspiration for, other regional impervious 'hotspots' (shown in red).*

***Data Engagement***

Where Systems Thinking addresses ideas in a more general sense, Data Engagement focuses on detailed information. Through a deeper understanding of these details, designers create the opportunity to utilize abductive processes, laying the foundation for Kolko's "argument to the best explanation" (Kolko 2010, 20). The challenge exists in avoiding informational overload and limiting the gaze into the infinite array of systemic details. Designers may also find it difficult to accept that certain information is not as useful as originally expected where efforts may ultimately be leading to dead-ends. Regardless, Data Engagement seeks to discover, organize, and relate informational findings where three primary tactics have been utilized in the CRW study – Matrices, Data Visualization, and Technology.

Matrices

Matrices serve as a basic form of informational organization utilizing tabular grid formatting. Their particular strength lies in enabling quick data input, extraction, and comparison. Within the CRW study, large amounts of data are arranged in a series of working digital spreadsheets. A sample of organized topics include sub-watershed land areas, imperviousness, zoning areas, land use divisions, canopy coverage, and municipal authorities as well as gauge locations, measured flow rates, and water quality indices. From this type of data arrangement, designers can observe that while the Lower North Branch Sub-watershed is the largest hydrologic subdivision of the CWS, it only contains five different municipalities (as compared to the second-largest Skokie River Sub-watershed, which includes fifteen). This has profound implications on institutional coordination. Data comparisons also indicate that despite being the smallest hydrologic subdivision, the South Branch Sub-watershed contains the second highest land area for high-intensity imperviousness. Combined with the nonlinear tactic of impervious 'hotspot' identification, this information supports a situational connection between areas that are miles apart. Having this type of information available in a comparative format presents designers with a greater opportunity to recognize larger landscape connections. More importantly, because it can be maintained in a working format (e.g. digital spreadsheets), designers are able to tactically cultivate of an up-to-date library of knowledge for future reference.

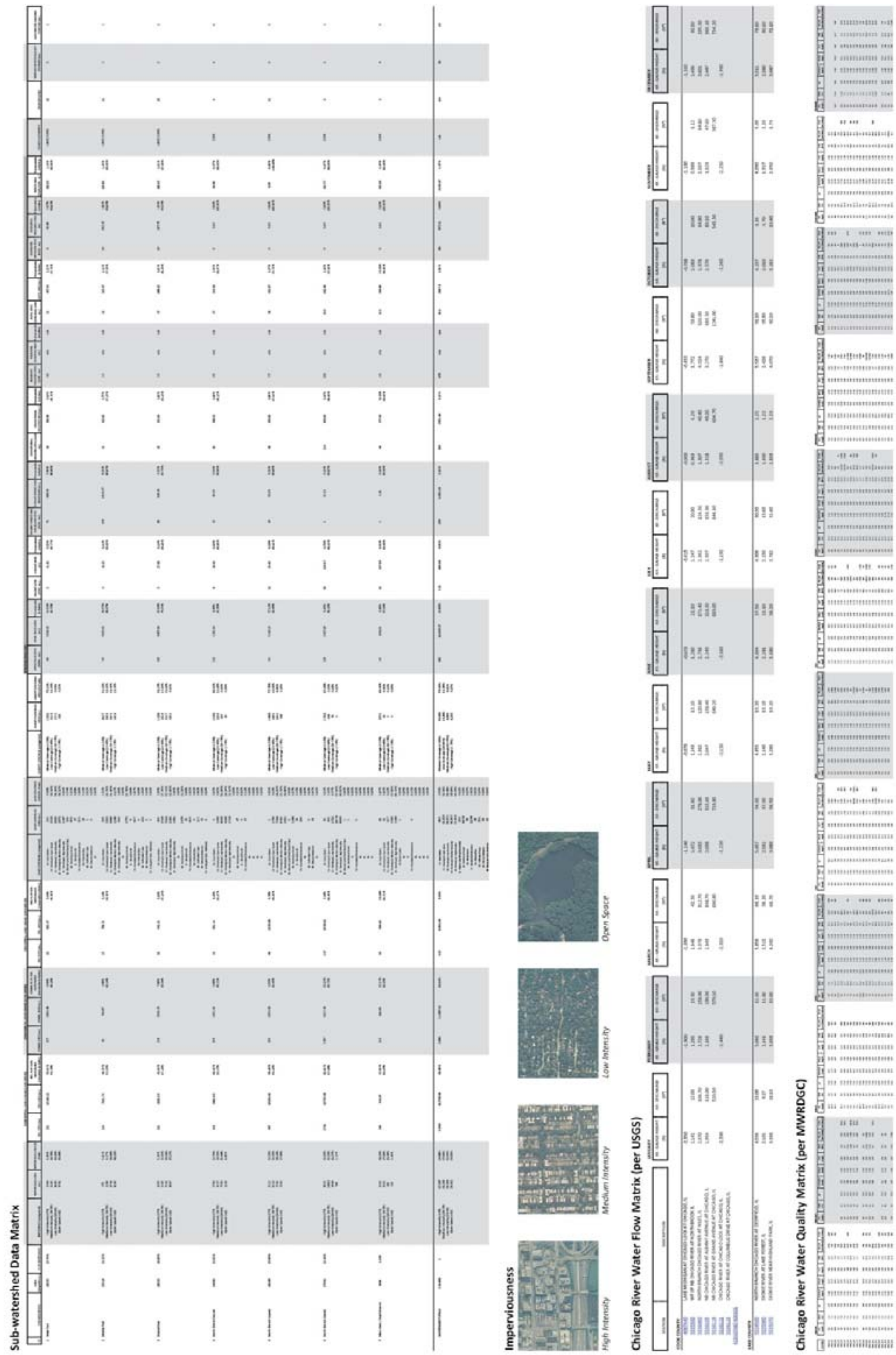



*Image 16 – A comprehensive view of all Chicago River Watershed value-based informational matrices.*

*Data Visualization*

As an extension of Matrices, Data Visualization utilizes the power of graphic imagery to communicate information. Numerical intelligence previously organized within tables is presented in more graphically intuitive fashions. For instance, information regarding a particular sub-watershed such as impervious or open space land areas may be tracked along a single thread (see Image 17) and compared to other sub-watershed threads. This visual representation, while offering the same information, is more engaging for audiences and serves as a more effective tool for communication. Text and grid structuring do not need to be abandoned (see Image 18) and can still be used as supplements to other forms of visual communication. Through the utilization of this tactic, designers employ a form of communication that is more alluring than simple, data-filled tables. In this regard, designers might consider utilizing Matrices primarily for internal organizational purposes and Data Visualization techniques when presenting to and conversing with external audiences.

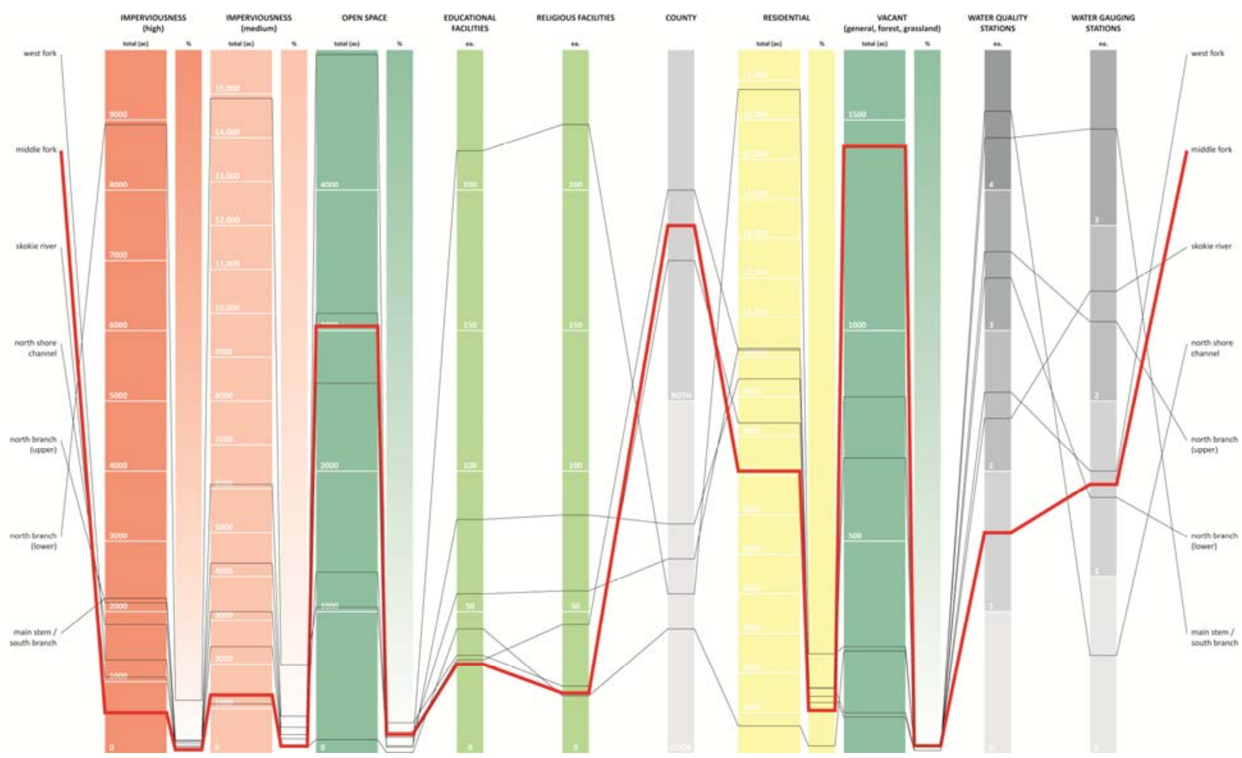



*Image 17 – Informational thread diagram as a way of visualizing data; the seven Chicago River Watershed sub-watersheds are listed along the left and right side of the diagram and correspond to a single thread that tracks quantitative data according to ten different categories listed along the top; through the utilization of digitally interactive tools (e.g. a mouse pointer hovering over and highlighting an entire thread), thread line identification can be greatly improved.*

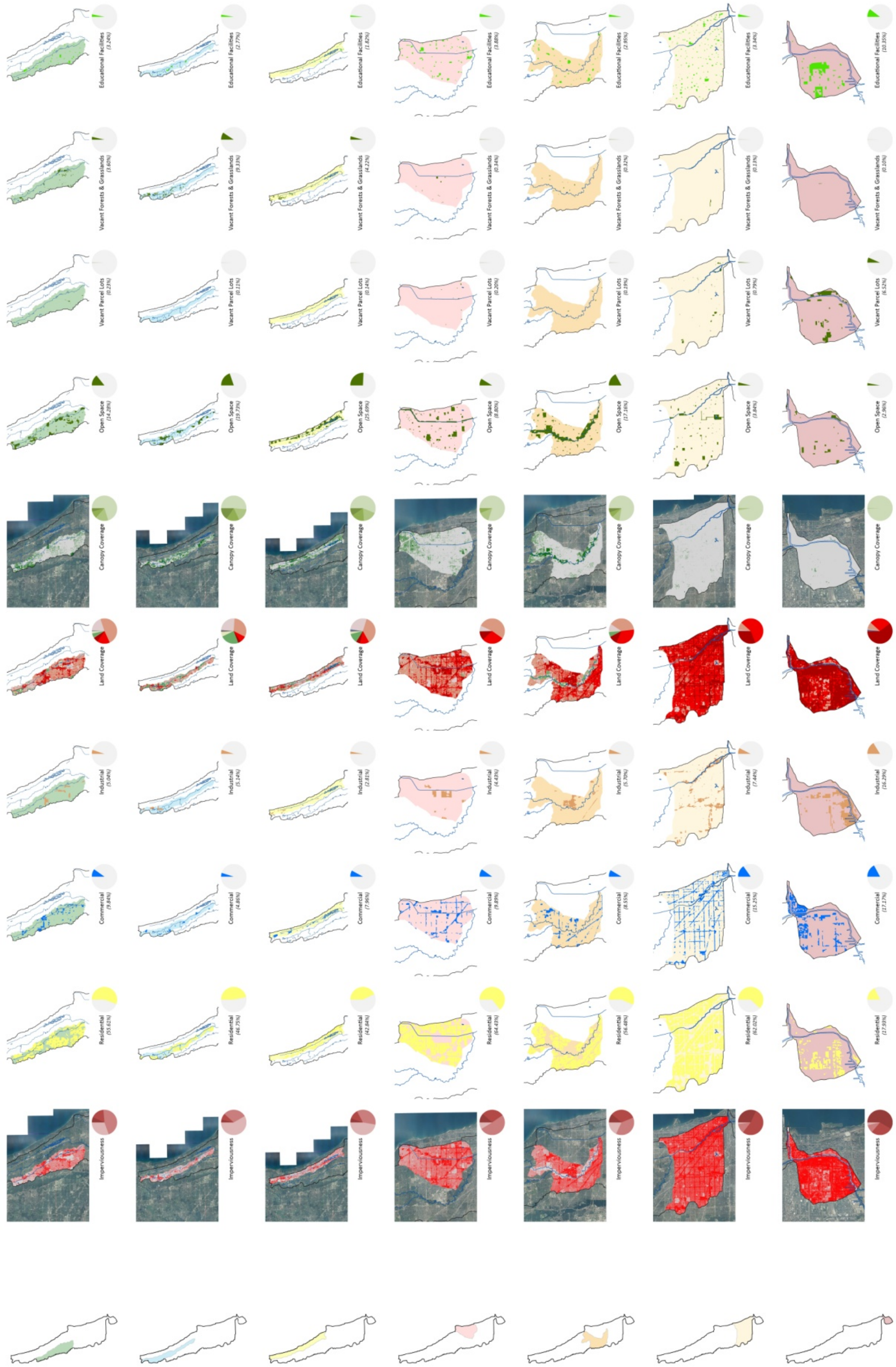



*Image 18 – Data Visualization technique that relates geospatial information in a matrix format.*

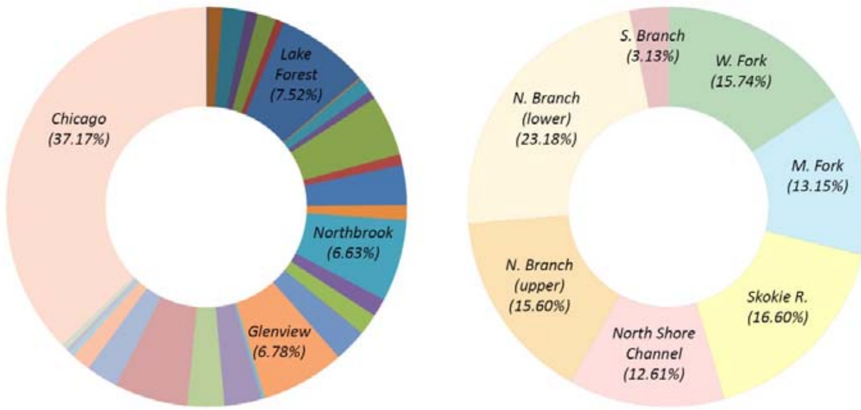



*Image 19 – Donut diagrams that communicate Chicago River Watershed divisions; while the sub-watershed donut (right; corresponding to Image 10) is effective, the municipal donut (left; corresponding to Image 8) is more difficult to interpret because of the larger quantity of divisions; this emphasizes the discretion needed for proper utilization of Data Visualization techniques.*

## *Technology*

Technology refers to the library of digital tools and resources that have largely emerged within the last ten to twenty years and have enabled a greater convenience in accessing different forms of intelligence. The Internet sits at the forefront of this digital library, providing access to resources such as agency publications, technical manuals, aerial imagery, and real-time monitoring data as well as institutional contact information and related links. This digital library of resources also includes the various personal computing programs – e.g. graphic production, geospatial referencing, drafting, spreadsheet generation, etc. – that are utilized as part of the data analysis process. Because use of these resources is becoming more commonplace in design fields, its utilitarian value is becoming more taken for granted. As part of the CRW study, Technology is directly identified as a tactical tool associated with Data Engagement. When combined with the organization of Matrices, designers can proactively enhance their up-to-date library of knowledge. What follows is a sample series of matrices highlighting key intelligence resources utilized throughout this study.

*Table 1 – Listing of Technology intelligences utilized in the Chicago River Watershed study.*

| MUNICIPAL INTELLIGENCES *(websites)* | | GIS INTELLIGENCES *(applications & websites)* | MAPPING INTELLIGENCES *(websites)* | GRAPHIC PRODUCTION INTELLIGENCES *(applications)* |
|---|---|---|---|---|
| Park City | Northfield | ESRI ArcGIS | GoogleEarth | Adobe Illustrator |
| Waukegan | Kenilworth | Illinois Geospatial Clearinghouse | GoogleMaps | Adobe InDesign |
| North Chicago | Wilmette | NRCS Geospatial Data Gateway | Bing Maps | Adobe Photoshop |
| Lake Bluff | Glenview | USGS Seamless Data Warehouse | | Google SketchUp |
| Green Oaks | Golf | CMAP Land Use Inventory | | Autodesk AutoCAD |
| Mettawa | Morton Grove | IDOT Illinois Technology Transfer Center | | Microsoft Excel |
| Lake Forest | Evanston | City of Chicago Geographic Information Systems | | |
| Highwood | Skokie | Cook County Geographic Information Systems | | |
| Bannockburn | Niles | Lake County Geographic Information Systems | | |
| Lincolnshire | Lincolnwood | NRCS Web Soil Survey | | |
| Highland Park | Park Ridge | | | |
| Riverwoods | Harwood Heights | | | |
| Deerfield | Norridge | | | |
| Glencoe | Elmwood Park | | | |
| Northbrook | Oak Park | | | |
| Winnetka | Chicago | | | |

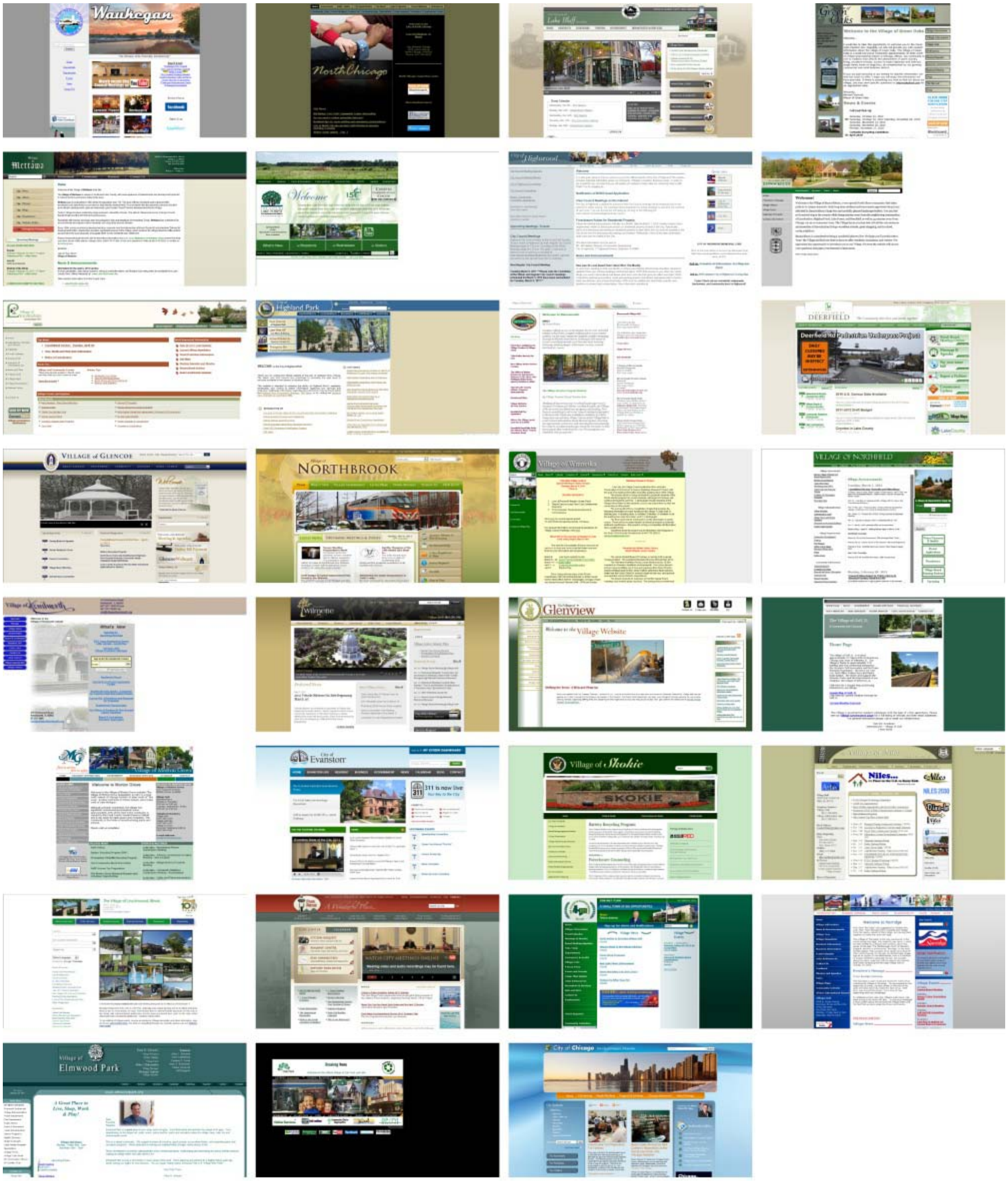


*Image 20 – Matrix of Chicago River Watershed municipal intelligence resources (websites); these include (listed from upper left to bottom right) Waukegan, North Chicago, Lake Bluff, Green Oaks, Mettawa, Lake Forest, Highwood, Bannockburn, Lincolnshire, Highland Park, Riverwoods, Deerfield, Glencoe, Northbrook, Winnetka, Northfield, Kenilworth, Wilmette, Glenview, Golf, Morton Grove, Evanston, Skokie, Niles, Lincolnwood, Park Ridge, Harwood Heights, Norridge, Elmwood Park, Oak Park, and Chicago (Park City does not have a website).*

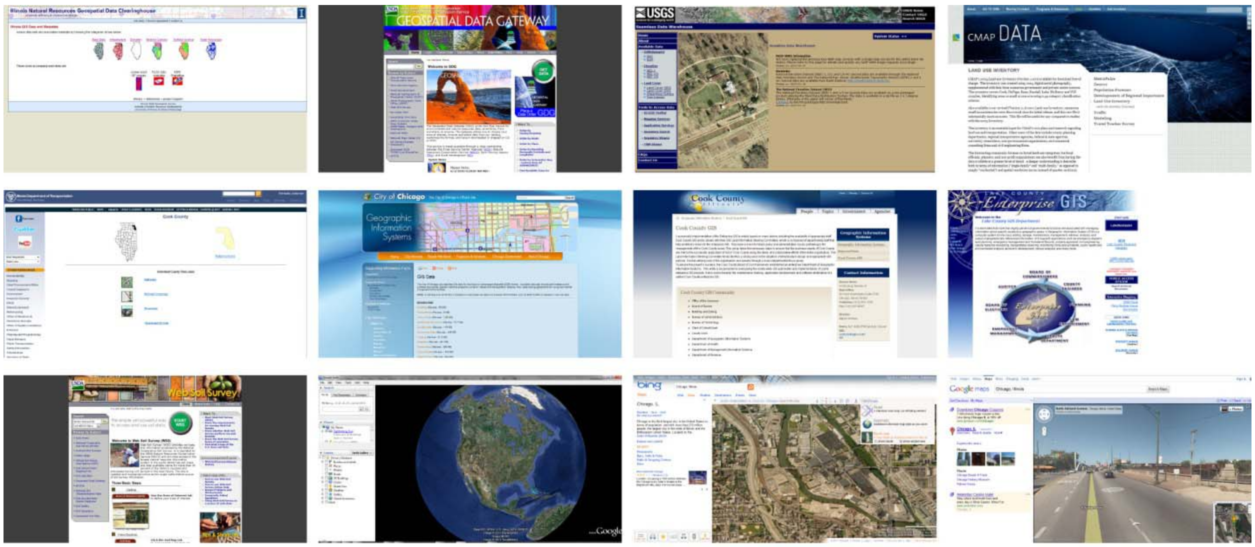



*Image 21 – Matrix of GIS and mapping intelligence resources (websites) utilized for the Chicago River Watershed study; these include (listed from upper left to bottom right) Illinois Geospatial Clearinghouse, NRCS Geospatial Data Gateway, USGS Seamless Data Warehouse, CMAP Land Use Inventory, IDOT Illinois Technology Transfer Center, City of Chicago Geographic Information Systems, Cook County Geographic Information Systems, Lake County Geographic Information Systems, NRCS Web Soil Survey, GoogleEarth, Bing Maps, and GoogleMaps.*

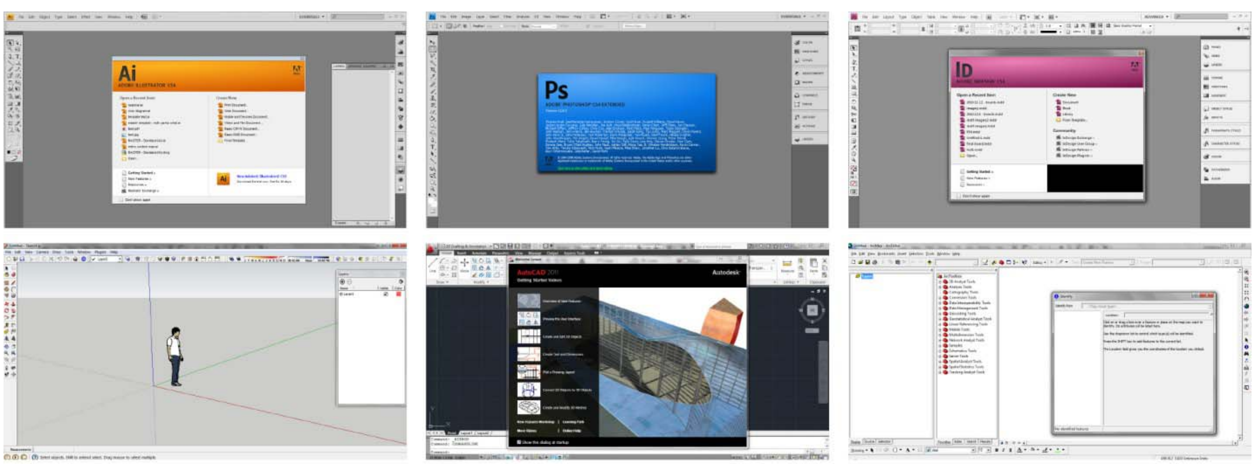



*Image 22 – Matrix of graphic production intelligence resources (applications) utilized for the Chicago River Watershed study; these include (listed from upper left to bottom right) Adobe Illustrator, Adobe Photoshop, Adobe InDesign, Google SketchUp, Autodesk AutoCAD, and ESRI ArcGIS.*

***Design***

Design acts as the pivot point from which intelligence gathered through Systems Thinking and Data Engagement is applied. It is the synthetic process that produces and develops concepts. Difficulty arises in determining which pieces of intelligence to use and how to potentially leverage them in conceptual development. An equally challenging obstacle exists in the effective communication of these concepts where ideas can lose supporting traction if poorly presented. This final 'drawer' of the strategic toolbox examines different tactics to be utilized in synthesizing intelligence, applying it to conceptualization, and communicating projective ideas to audiences. Recognizing that there are a limitless number of design approaches, the CRW study focuses on three strategies – Diagramming, Branding, and Monumentalism.

*Diagramming*

Diagramming assists communication through graphic organization and simplified representation. A critical challenge of this technique involves finding a balance between the creation of informative imagery and avoidance of oversimplification (and in some instances, over-complication). Numerous diagrams have already been presented throughout this study, but the following focuses on engaging two differing content types. The first (see Image 23) offers a visual representation of an organized idea – the preliminary structure of this study. The content is more cerebral than land-based, which is to say that it organizes thoughts rather than physical objects or spaces. Its use can be applied to the visual representation of mental concepts, including project goals/objectives and programming relationships as well as natural food webs, energy transfer systems, and hydrologic networks. The second (see Image 24) presents a graphic that organizes space – a site in the South Branch Sub-watershed. Its use can help to define adjacent contexts and access points as well as internal circulation patterns, spatial organization, and ecological relationships. While this particular image series focuses on the site scale, Diagramming can also be applied to larger regional extents (see upper right graphic of Image 28). This tactic enables designers to present systemic ideas to an audience in an easier-to-understand fashion and has the ability to be used at any scale. It also assists in framing complex situations by requiring designers to distill key elements and relationships. Through Diagramming, the designer gains a better systemic understanding by determining the critical pieces of information to be conveyed to audiences and how they can be most effectively communicated.

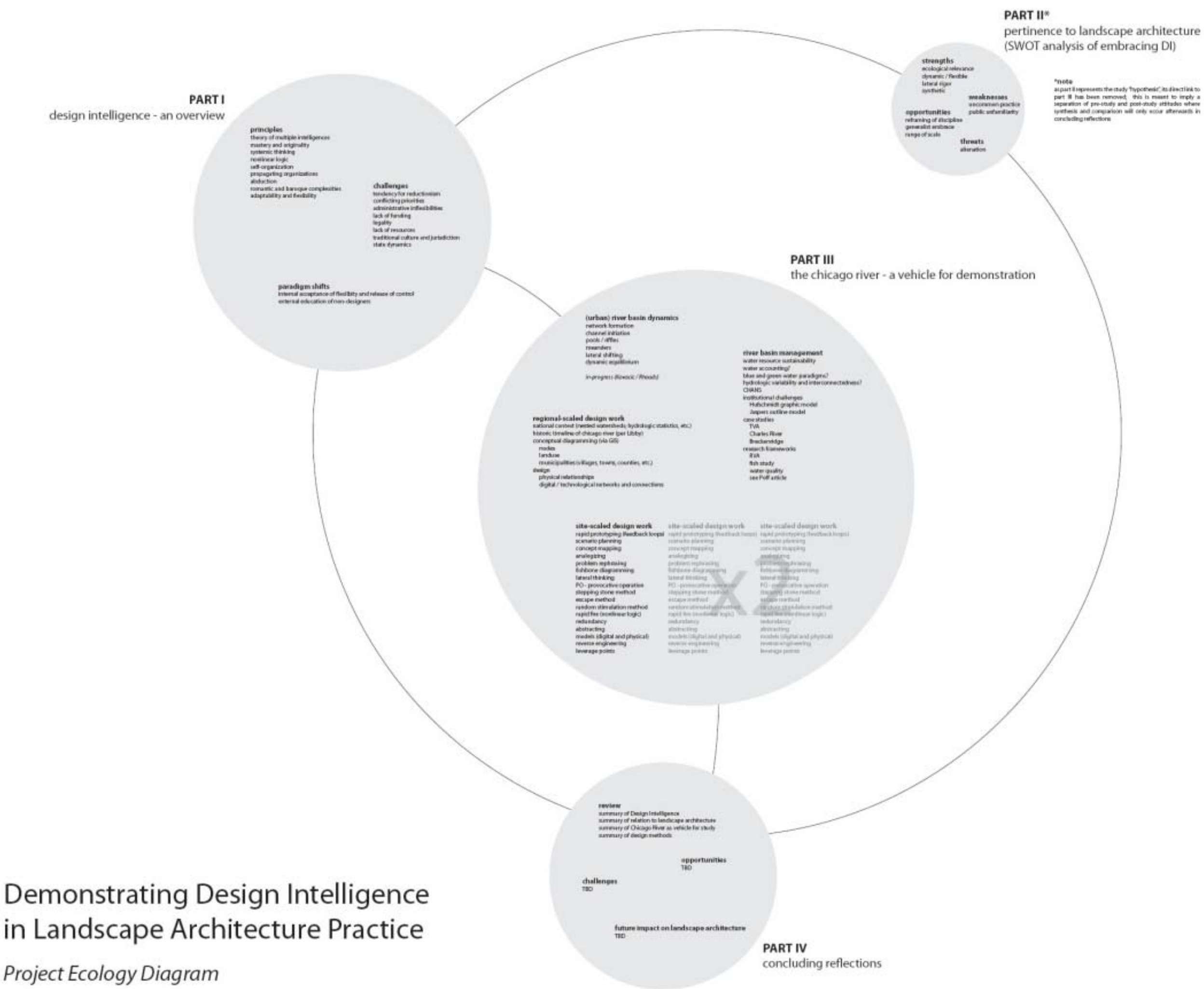
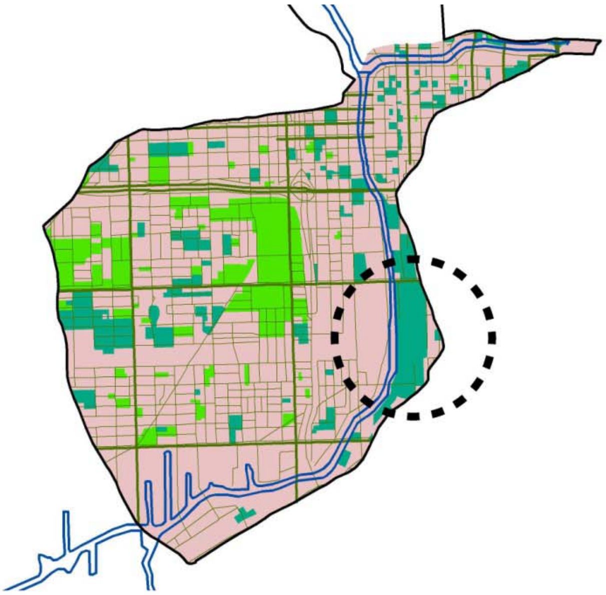



*Image 23 – Early project diagram utilized for purposes of internal project organization.*



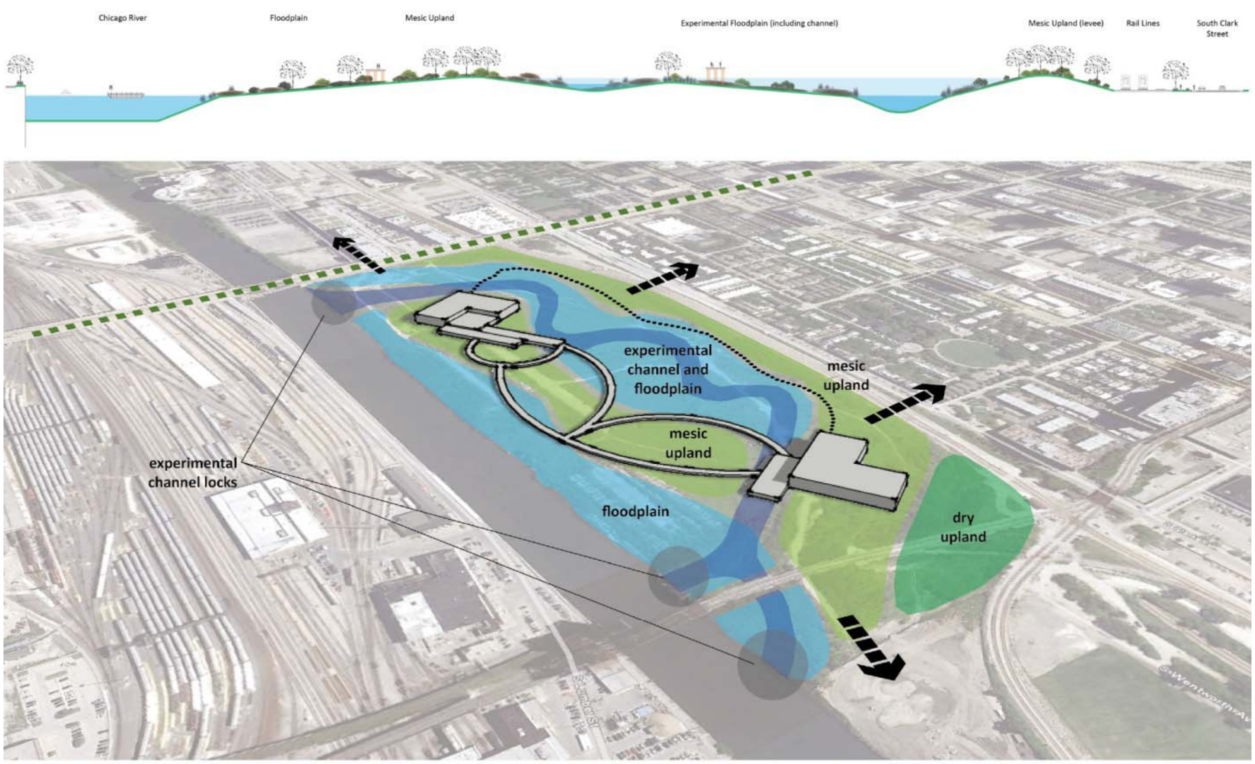



*Image 24 – South Branch Meander site diagram and corresponding section; simplified representation of zones, paths, buildings, and off-site access connections convey spatial relationships where experimental stream meanders are introduced into the site; the diagrammatic nature of the image presents the fundamental conceptual idea but leaves detail work to future design development.*

## *Branding*

Branding refers to a marketing technique whereby an identifier – a symbol, slogan, name, etc. – is used to distinguish a product or service. This same approach can be applied in Design as a way to establish projective themes. Smaller design components can be linked to over-arching concepts that unify a project where fluidity between scales is maintained and communication with the audience is enhanced by structuring concepts to relate to each other. Within the CRW study, Branding has been applied in referring to the Chicagoland region as Water City, USA (see Image 26). Utilizing systemic elements identified in regional analyses (see Image 11), four key features organized under hydrologic terminology contribute to this themed concept – Channels, Confluences, Pools, and Springs (see Image 25). Sites serve their own functions but also hold importance within a unified regional context. Branding enables designers to promote concepts beyond the traditional restraint of site boundaries and project creative opportunities for larger initiatives. It also employs intelligence obtained during Data Engagement to encourage larger, systemic perspectives.

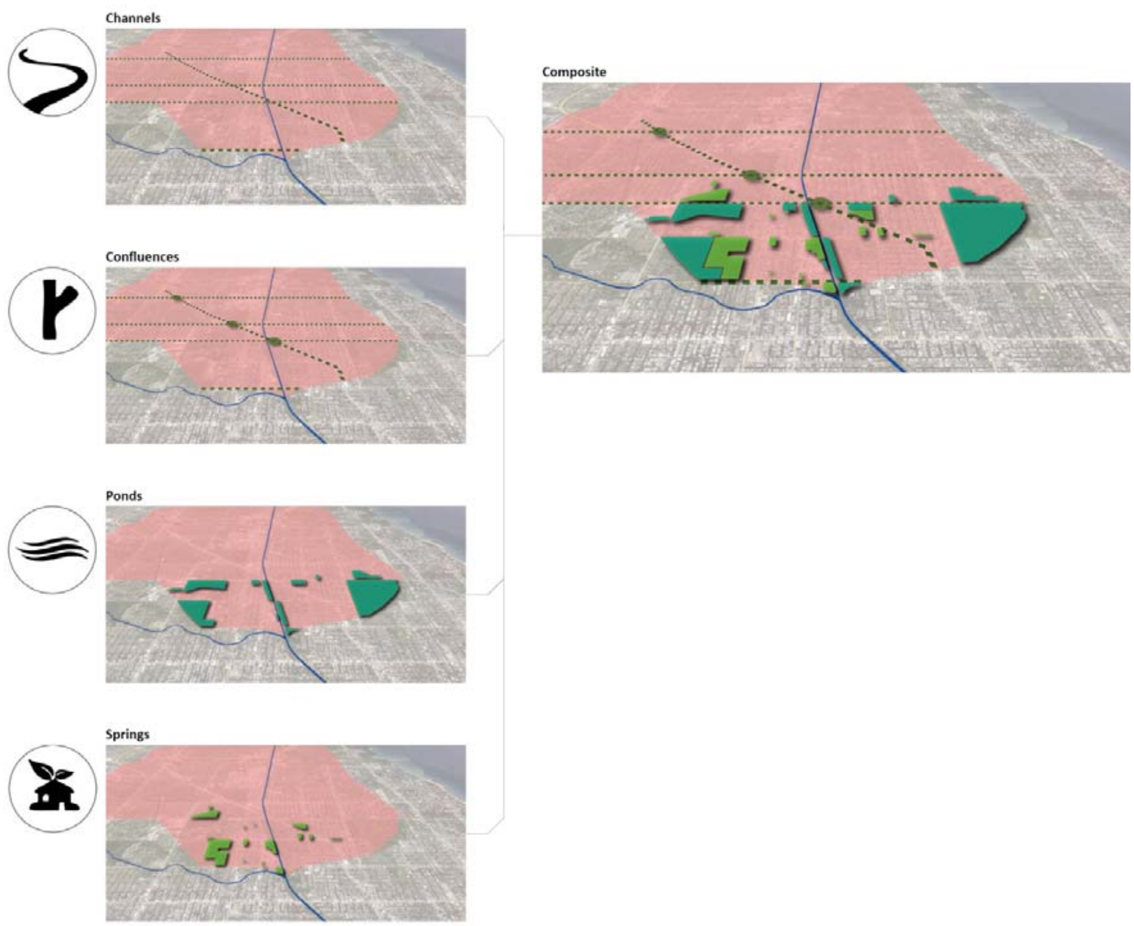



*Image 25 – Referencing elements identified during regional analyses (see Image 11), a series of icons are utilized to develop a regional design theme based on hydrologic terminology; building upon Growing Water, 'Channels' represent the key transportation corridors that are utilized to direct water flows; 'Confluences' represent locations where these corridors intersect (see also Image 13); 'Ponds' utilize open space – parks, cemeteries, vacant lots, etc. – as opportunities to store and harvest water (see also Images 28 and 29); and 'Springs' serve as gathering places – based primarily on education and religious facility locations – where communities can meet to discuss water-related issues (see also Image 24).*

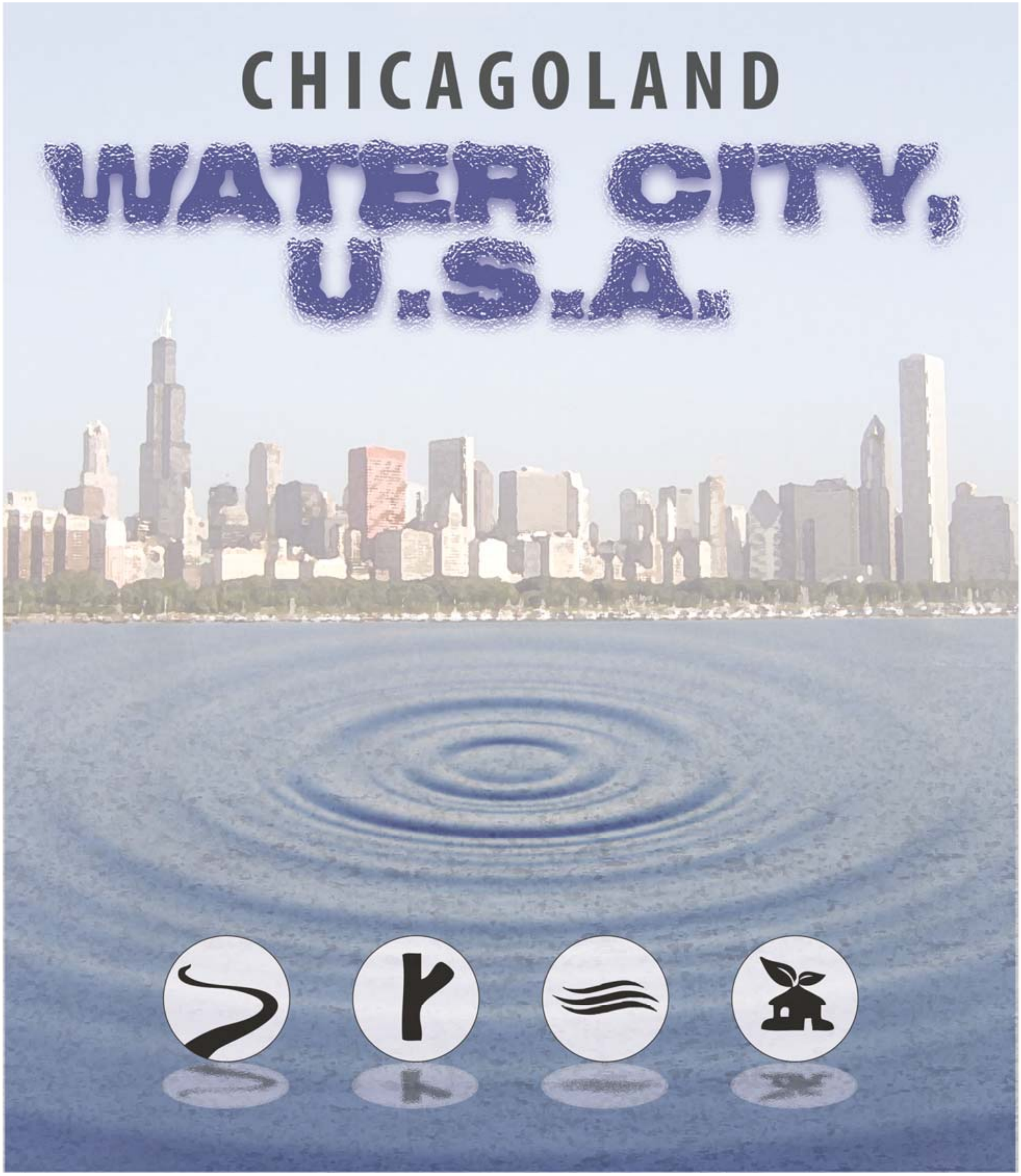
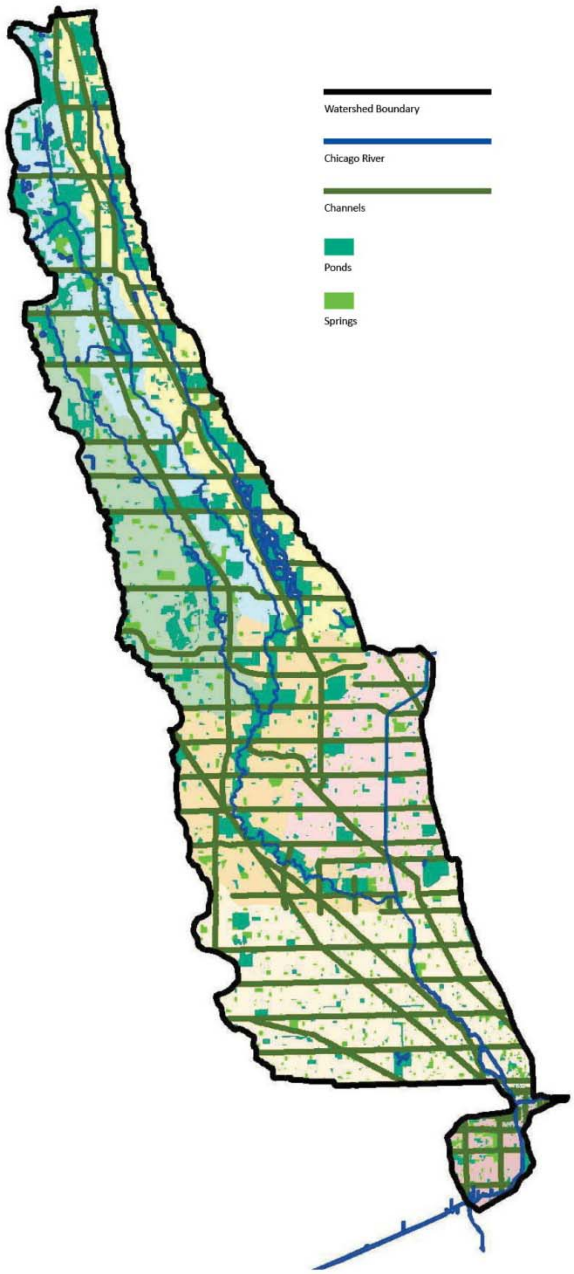



*Image 26 – Branding poster based on the hydrologic terminology theme (Channels, Confluences, Pools, and Springs) that frames the Chicagoland region as 'Water City, USA.'*

*Monumentalism*

Monumentalism embraces the Daniel Burnham mentality of 'Make no little plans. They have no magic to stir men's blood.' It is a tactic that strives to push boundaries in every sense possible – economically, ecologically, and culturally – yet at the same time, does not suspend design beyond the limitations of physical reality. Monumentalism builds upon the notion of grounded speculation where thought-provoking design work, in spite of seeming impracticality, maintains a fundamental basis in scientific principles. Within this framework, the CRW study pushes both aspects of this tactic by envisioning a 'softer' regional hydrologic infrastructure based on Channels, Confluences, Ponds, and Springs (see Image 27, left). It concurrently envisions a system of research-based hubs located along the Chicago River corridor, representative of individual municipal interventions seeking to establish a riparian monitoring network (see Image 27, right). Loftier in its projective speculation, the CRW study also considers the implementation of floating water-pads, adapted from concepts developed by Lola Sheppard and Mason White of Lateral Office, in harnessing the Skokie Lagoons as a regional freshwater drinking source (see Image 28). Lastly, the CRW study envisions wetland treatment systems (see Image 29) that expand beyond single sites and encompass entire communities and neighborhoods. While each of these concepts presents enormous obstacles to overcome, they begin to frame landscape interventions in a more projective fashion, arguably necessary for the effective engagement of emerging twenty-first century challenges. Monumentalism encourages designers to confront these challenges by thinking realistically, but doing so in a way that is systemically provocative.



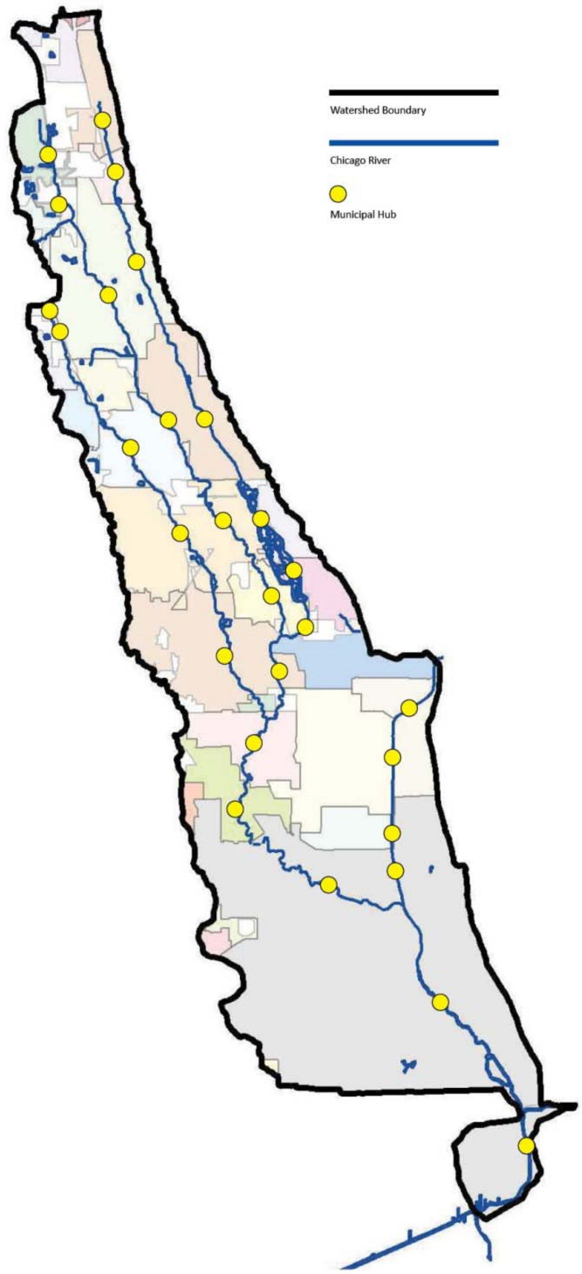




*Image 27 – Regional design plan (left) that applies the Water City, USA branding concept to the entire Chicago River Watershed; regional design plan (right) that identifies municipal hubs representative of each institution; while each hub exists as an individual site, it also serves as a contributing piece of a larger research-based network.*

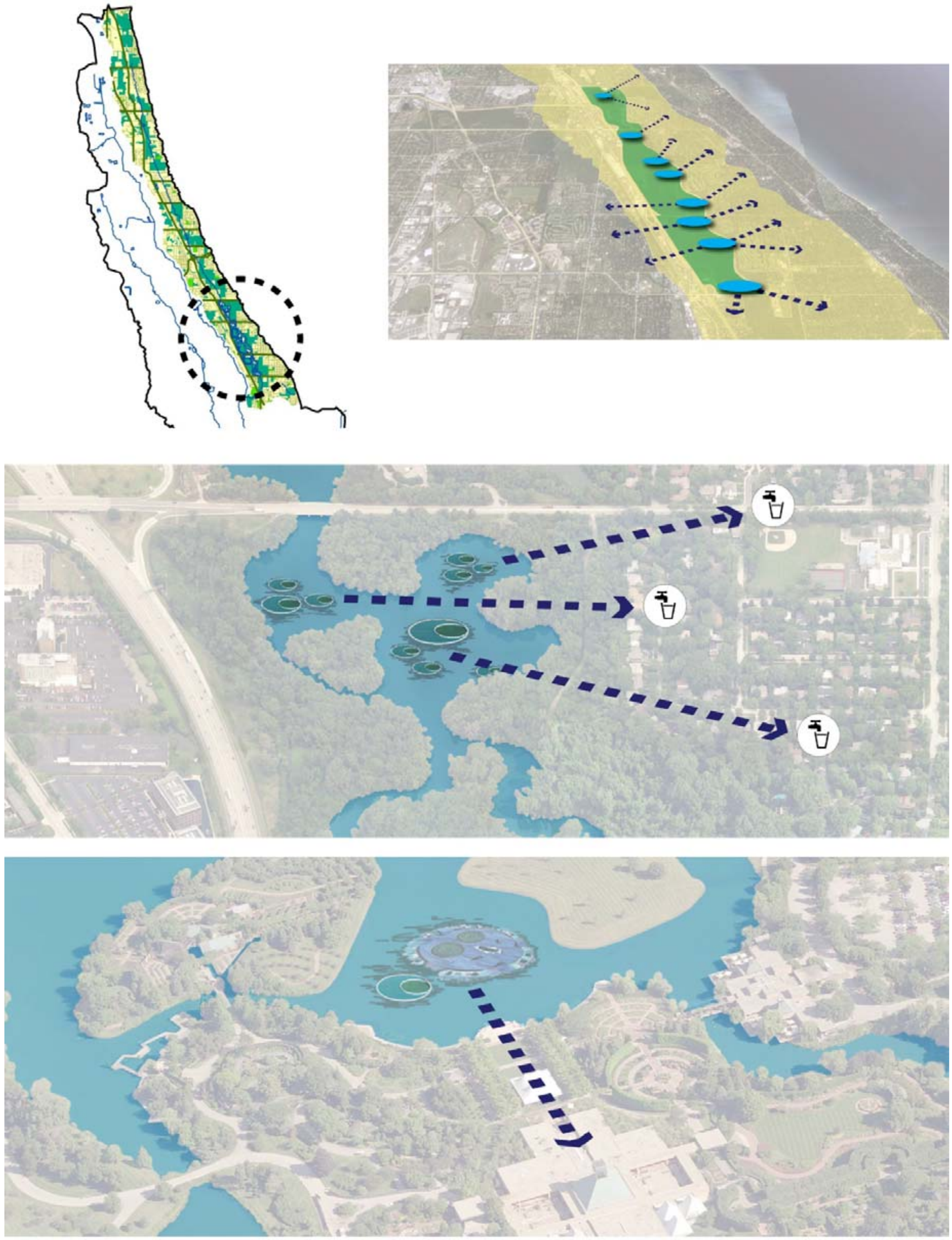


*Image 28 – Potential interventions at the Skokie Lagoons (top and middle) that utilize water-cleansing cells to provide drinking water to nearby communities; other interventions within the lagoons at the Chicago Botanic Garden (bottom) create aquatic-based gardens and provide unique wildlife habitat (concept and imagery adapted from Sheppard 2009).*

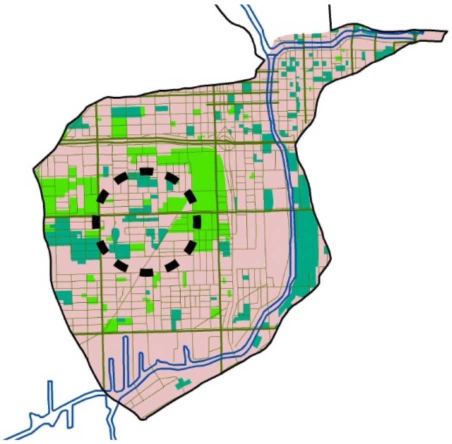


*Image 29 – Based on regional analyses that identify vacant lots, urban parcels are converted to water storage sites that are linked via thematic Channels; not only does this push site functions beyond the limits of individual site bounds by establishing an expanded wetland system, but it also contributes to the regional Water City, USA theme.*

## CHAPTER 5 – CONCLUSIONS

A discussion of design in the twenty-first century is obligated to be mindful of issues related to the concept of sustainability. Rooted within this thesis is a critique of traditional landscape architecture design practices as being limited by existing institutions and too reductive and site-focused to properly address complex regional landscape contexts. Fundamental in engaging these complexities is the proactive cultivation of intelligence – the bricolage of knowledge that individuals, firms, project teams, non-profits, and municipalities, among others, must develop to not only operate at the most basic design level but more importantly, to fully engage with today's complex social-ecological challenges. This notion of intelligence is positioned within a theoretical framework of ideas that include systems thinking, nonlinearity, self-organization, adaptive management, abduction, scale fluidity, situational framing, and lateral rigor.

This thesis proceeds to utilize these concepts in an engagement of intelligence specific to the Chicago River Watershed (CRW) with the intent of demonstrating through a vehicle of study landscape design strategies more systemic than traditional approaches. A starter toolbox of tactics emerges that addresses techniques that can be employed to take on issues of complexity. This is not a comprehensive toolset; it is a listing meant to evolve over time and ultimately act as a springboard to the development of greater techniques. What follows is a brief assessment of implications associated with this systemic landscape design strategy that clarify its strengths, weaknesses, opportunities, and threats.

The primary strength of this approach lies in its ability to engage "messy, indeterminate situations" (Johnson 2007, 15) that are difficult to address using traditional reductivist design methods. Tactics such as Systems Recognition and Scale Fluidity strive to link global issues with site-specific details while Nonlinearity accepts the inevitability of uncertainty. In this manner, an intelligence-based systemic approach maintains flexibility and a resiliency to changing parameters.

Conversely, the main weakness of this approach involves its inherent focus on process rather than product. This suggests that projects remain in a state of flux as new intelligence is discovered, and a final design plan is never achieved in the absolute sense. As noted by Wondolleck and Yaffee, this is problematic when stakeholders expect results. The flexible adaptation and relaxation of control that accompany intelligence-based systemic design encounter traditional project management hurdles to overcome. Additionally, concepts associated with Design tactics such as Monumentalism present challenges by offering ideas that may initially be considered far-fetched and consequently dismissed, despite a basis in grounded speculation.

Opportunities include chances to effectively engage modern design issues in ways different from traditional reductivist methods. Strategies of Systems Thinking and Data Engagement hold the potential to encourage designers to expand conceptualization beyond site limitations, to push design bounds with different forms of intelligence, and to earnestly pursue self-education and resource awareness. Design tactics such as Branding enable designers to communicate small-scale ideas in relation to larger thematic issues, and Monumentalism challenges the maxim 'Don't reinvent the wheel' because this is exactly what emerging sustainable complexities require (Boland 2008).

Such opportunities, however, are not without threats. Adaptive techniques may create circumstances that make organizations anchored in conventional practice uneasy. These may include established professionals set in their ways as well as traditionalists who would rather utilize proven best management practices rather than go through the aggravation of implementing new project measures. The threat, then, emerges when systemic designers venture too far beyond the realm of grounded speculation and subsequently lose credibility. Their overall design effectiveness may diminish, and their ability to offer projective concepts may be hindered by anxiety of pressing too hard upon design bounds.

Regardless of exact means and methods, a general need is emerging for twenty-first century designers strongly versed in the synthetic, flexible, and projective strategies necessary for effective planning/design within complex regional landscapes. It is a need that demands a lateral rigor that connects and catalyzes professions from across all fields of design as well as those outside its traditional realm. It is also a need that requires an adaptive ability to engage an indeterminate medium and a capacity to move fluidly between scales. In these respects, landscape architecture may exist as the discipline most up to the challenge.

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## APPENDIX – IMAGE FILES

Many of the included graphics were originally created for formats greater than 8.5”x11” page sizing where reproductions within this document are subsequently difficult to interpret. Therefore, larger digital files of all imagery have been provided as supplementary material, organized according to corresponding publication image numbers.